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Social Information and the Regulation of Social Development



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СОЦИАЛЬНАЯ ИНФОРМАЦИЯ
И УПРАВЛЕНИЕ ОБЩЕСТВОМ

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Both in today's scientific studies and in today's practice there is probably no conception that is more widely employed than that of "information". And at the same time no other concept has generated so many arguments, discussions, and different points of view. These differences are apparent with regard to many issues, including the nature of the substance of information, its characteristics, the forms in which it manifests itself, its relation to the laws and categories of philosophy and its role in management and guiding the life and development of society. And while at the present time scientists have not yet agreed upon the essential nature of this remarkable phenomenon, while they continue to search and find additional characteristics and also juxtapose it to manifestations of social existence that have long been established and also continue to identify its role in the interactions that characterize social processes today, the fact remains that information does exist and live, and unfold an increasing number of its characteristics as it penetrates all spheres and all sectors of social life. It influences both mankind and individual persons, their lives, their way of thinking, and their mode of behavior. It poses a large number of problems before mankind and forces it to expend a growing volume of material, financial and labour resources to solve them.

Such expressions as "information boom", "the revolution in information" and "the information industry" continuously appear in titles of newspaper and journal articles as well as of books,

Each year approximately seven billion pages of printed text are added to the information flow. To process and store such an enormous mass of data calls for a gigantic effort. To retrieve needed recent data, not to mention assimilating it, is even more difficult. And it is in fact not surprising that more than one half of the materials available in the USSR's largest library, the Lenin State Library, remain unused. Nor is it surprising that today, for purely physical reasons, the average scientific worker is able to study only a tenth of the literature that is published in his own area of specialization throughout the world. Nor is it surprising that in the practice in the United States whenever a research project costs less than \$50,000 it is generally treated as a new project in view of the high costs of comprehensive information searches in a given area.

Above all a growing volume and flow of information is associated with the exceptional growth of complexity in production and in all spheres of social life. Both modern society and the individual links of which it is composed represent a network of extremely complex dynamic systems. The number and diversity of components within these systems is large and so is the volume of their interactions with each other and also of the system as a whole with its environment. Without information processes it is not possible to maintain the integrity of a system and its qualitatively definite character as well as its functioning and development. The greater the complexity of a system, moreover, the larger the number of components that it contains and also of interacting factors and different linkages, the larger will be the volume and variety of flows of information required for regulating its functioning and development.

It is therefore quite natural that many thousands of scientists as well as of technical specialists, political leaders and specialists in the functioning of mass media are deeply engaged in studying problems associated with information. Attempts are being made to find principles of information policy both at the level of individual states and of the world as a whole.¹

¹ E. L. Brady, L. M. Branscomb, *Information for a Changing Society*. In: *Science*, Vol. 175, No. 4025, Washington, 1972, pp. 961-66.

It is widely recognized that the capacity of a social system to carry out useful work in order to obtain materially and spiritually valuable outputs is determined by the quantity of energy that it is able to access.

Yet it is the "information capacity" of a society that provides a key to obtaining energy not to mention its rational utilization. This term refers to its scientific, technical, technological and organizational knowledge and the existence of effective means for obtaining, accumulating, storing, processing and transferring and utilizing information. It is only when such knowledge exists that it is possible to take material and energy resources from nature and to organize production and the rational management of technical and technological processes and then, on that basis, social and spiritual processes. The absence of information makes it impossible to access energy, to search for new forms of energy, and to utilize it in more effective ways. In its most general form the progress of a society depends on the extent to which it is equipped with a material, energy, and information infrastructure.

It is important to emphasize that the effect, objectives and forms of utilization of matter, energy and information ultimately depend on the character of a given society and on the system of social and particularly economic relations that characterizes it.

The rate of growth in knowledge and in the accumulation of valuable information is an important indicator of social progress. Nevertheless this is not the most important indicator nor the only one. Taken by itself information is not able to increase the production of valuable material and cultural outputs. It is useful only when it is embodied in equipment and technology, in the valuable outputs of culture, in the knowledge and experience of persons, in forms of communication among them and into the entire system of social relations. The value of information is effective only when it contributes to the development of the material, energy, and spiritual potential of persons and contributes to their comprehensive development and further improvement.

While an enormous amount of information is produced in the capitalist world and large numbers of persons are

engaged in work on information as well as modern technical equipment, there information continues to be a commodity and as such is subject to purchases and sales. "The fate of information," wrote N. Wiener, "in the typically American world is to become something which can be bought or sold."¹ It follows that since the production of information is one of the forms of spiritual production it is one of the forms of production and reproduction of surplus value and of profit. While it is a product of collective labor and a common heritage because it is a specific type of commodity, information is reproduced on an expanded scale and distributed and consumed in the bourgeois world in accordance with the laws of capitalism.

As for its class essence, this follows from its economic essence, which is determined by the interests of the capitalist class in asserting and maintaining its rule, power, and privileges.

In such a context information generally, and especially social, political and cultural information, plays an important ideological role in serving as an instrument for manipulating the consciousness and behavior of persons in the interest of capital.

In a book entitled *Marxism and Informatics*, a French Marxist researcher, Jean Claude Quiniou, notes the misleading nature of the fashionable thought that in capitalist societies computers liberate man from undesirable forms of obligations, leaving more leisure time for higher forms of creative activities. In practice the situation is altogether different: the development of the information industry produces a further stagnation of the personalities of very large numbers of persons engaged in serving that industry and subjects them to extreme forms of exploitation under which "neither through the payment for labor nor through the tasks that it is assigned is it possible to establish the dimensions of the product that is being utilized for alienating other individuals."² According to Quiniou all the social

¹ Norbert Wiener, *The Human Use of Human Beings. Cybernetics and Society*, London, 1954, p. 113.

² J. C. Quiniou, *Marxisme et Informatique*, Paris, 1971, pp. 37-38.

activities in which capitalists engage may be reduced to the accumulation of profits.

It is only in a socialist society that science, technology, and information are placed at the service of society as a whole as well as of each individual, and that they are subordinated to the objectives of a harmonic and comprehensive development of the personality. In such a context information is not an object of unscrupulous commerce. Instead it is a heritage of the entire people that is produced as well as utilized by the people in the pursuit of its own interests.

Information systems play an increasingly large role in the development of socialist societies. They serve communication among people, social groups, classes, nations and states, and contribute to the development of a scientific world outlook by individuals. They assist them in arriving at their own understanding of the diverse phenomena and processes that are taking place in social life, in increasing their level of culture and their general education, in assimilating and carrying out laws and moral principles, and in struggling with bourgeois and revisionist ideologies that are foreign to socialist moral norms.

Occasionally one hears references to an "information explosion" which is said to have burst upon mankind as if it were a terrible catastrophe. But a more careful consideration of this phenomenon indicates that it is not so frightening after all. Both the fragments in question and the manner in which they are scattered are hardly dangerous, provided, of course, that they are regulated and directed in a reasonable manner and that they produce neither a loss of human lives nor destruction. On the contrary they bring to man an awareness of the actual scope of his power, and of the fact that he does possess the capacity for utilizing the powerful forces of nature to his own benefit, and to create a society in which men engaged in labor occupy a central position. This refers to socialist and communist societies which alone are able to tame the "information explosion". There, within socialist structures, the production, circulation, and utilization of information is subjected to scientific and conscious management, as are all other spheres of social life and also society as a whole.

At the present time when a rich experience has already been accumulated in activities relating to information in a socialist society, when a substantial number of works have been published that are concerned with this problem, and when problems on the further improvement of management are occupying a central position, there is an urgent need for studies of the essence, characteristics, and role of information in regulation and in society. In short there is an urgent need for creating a theory of social information.

The task that was envisaged by the present author in this study was to rely on Marxist-Leninist methodology in identifying initially the qualitative, substantive aspects of social information, while utilizing at the same time the possibilities developed by mathematics, cybernetics, and engineering psychology as well as other sciences.

The present study is therefore concerned with such issues as the following: What is the essence of information generally and of social information in particular? What is its role in guiding the development of society? What is its relation to man and to society and its place in the revolution in science and technology? What are the prospects for the development and utilization of information and of information processes?

The author by no means claims to provide a comprehensive definition of information and of information processes and claims even less that the assertions and conclusions that he is proposing are not subject to further questioning. He hopes that this study will serve to stimulate the development of a more accurate and more comprehensive interpretation of the remarkable and still inadequately understood phenomenon of our own age that is described as social information.

He wishes to express his deep respect and gratitude to all the authors of the works in the field of information, that have been employed in the present study, and to all those, who through their advice, support, and critical comments have assisted him in writing this study and in making it available to readers.

CHAPTER I

ON THE CONCEPTION OF INFORMATION

Because at the present time it is mathematical theories of information that have experienced the greatest measure of development we will consider them first in our analysis of currently available approaches to the understanding of information.

1. MATHEMATICAL THEORIES OF INFORMATION

Information theory emerged as a quantitative mathematical theory. Its creator, C. Shannon, is an American engineer and mathematician who relied on methods of probabilistic statistics in identifying the quantitative aspect of information which he viewed as a reduction in uncertainty.

As society experienced a further development, and production as well as all other spheres of social life became more complex, as means of communication and forms of human communication developed enormously so did the quantity of information. A need arose for measuring information, determining its quantity, the carrying capacity of channels of communications, and the ordered restructuring of information processes. It is this which Shannon's theory of information made possible. By establishing a measure of quantity of information it contributed to a sharp increase in the carrying capacity of communication channels.

This theory of information which is based on probabilistic statistics views information as the opposite of uncertainty

and the sublated uncertainty. This provides a basis for defining the quantity of information as the degree of reduction in uncertainty produced by transmitting messages. In a situation in which an event may have two equally probable values, a reply to a binary question ("yes" or "no") constitutes a minimum quantity of information. That reply is transmitted along communications channels in the form of a physical signal possessing one of two equally probable values ("0" or "1"). It is to such an answer to a single binary question transmitted along channels of communications with the help of a signal that the minimal unit of information, namely the bit, corresponds. The quantity of information measured in terms of bits that is contained in a message is determined by the number of words in a natural language, the number of signs in each word, and ultimately by the number of binary signals that are necessary to express each sign.

In developing the statistical theory of information further a still more general formula for the quantity of information was elaborated that applies to continuous entities.

Because the statistical theory of information is concerned with a quantity of information associated only with signs and statistical relations among them it is called a *syntactical* theory. The probabilities that it studies represent relative frequencies of such signs or else their measures. Above all the signals themselves, their frequency and reliability as well as the quantity of information that they contain are all viewed independently of their contents, meaning, and value. The primary concern of mathematicians and technicians is to assure a correct transmission of signals in the sense of physical carriers of information.

Syntactical properties of information are employed in the preparation of primary data as well, since the primary documents are made up of signs associated with a specific informational language. In such a context both the signs and symbols expressing information and the relations among them are studied and specific rules for collecting, registering, and minimizing information and for transmitting signals are followed.

While the boundaries within which this information theory may be applied are rather clear and remain within

the sphere of problems of communication, attempts are continuing to apply it in areas that actually call for a different approach. C. Cherry, a prominent British specialist in the general theory of communications, cybernetics, and psychology, observes that. "It (the mathematical theory of communication—*Ed.*) has a right and proper place in the study of communication, which its originators thoroughly understood, and attempts to extend it outside the technical field in which it first arose will be fraught with pitfalls."¹

C. Cherry is particularly concerned by the illusions and disappointments that will accompany attempts to apply this statistical theory to studies of social information for the latter are always associated with psychological factors that do not lend themselves to formalization and quantitative measurements. He notes that the theory of information communication is a strict mathematical theory that is based on the assumption that an alphabet of signs is given and that probabilities correspond to the relative frequencies of their appearance, that is, to density functions. Whenever this is not true it is not possible to provide a quantitative estimate of information that is to express it in terms of binary digits (bits). At the same time it is precisely in the context of solutions to psychological problems that references are made to probabilities as measures of certainty, for which there does not exist at the present time any quantitative measure and for which a fixed and closed alphabet of signs has not been defined.²

This does not mean, of course, that statistical theory is altogether inapplicable in other areas. C. Cherry observes that to a certain extent syntactical aspects are elaborated with the help of mathematics while its semantic and pragmatic aspects are only beginning to emerge, although they continue to remain generally unclear and poorly defined. It is true, of course, that the formal statistical theory of communications has opened certain perspectives for applying both that theory itself and also the measure of "selective information" that it has developed in different sciences that

¹ Colin Cherry, *On Human Communication. A Review, a Survey and a Criticism*, Massachusetts Institute of Technology Press, 1966, p. 7.

² *Ibid.*, p. 276.

are themselves associated with the idea of information in a variety of ways. Nevertheless, whenever attempts are made to extend the conclusions of existing theory beyond its legitimate boundaries and the precise sphere of application for which it is appropriate, great caution should be exercised. "Information of *some kind or other* certainly appears to be a concept of value in many fields, but this is not to say that the one mathematical theory and one measure have indiscriminate application."¹

In spite of the great usefulness of the probabilistic approach to information, that approach is limited, since it does not make it possible to define the quantity of information in an individually developed object or system. Under a probabilistic approach such an object will be viewed either as an element of some statistical entity or else as a statistical entity of weakly related elements. The organic nature of relations within the object itself (and social systems are organic systems in such a sense) is not taken into account. It is therefore not surprising that within the class of mathematical theories of information other approaches are also being developed that are nonstatistical and are based on a set theory approach. One of them is the *algorithmic* approach, which has been proposed by Academician A. N. Kolmogorov. It is based on a method of universal programming. Under an algorithmic approach it is possible to compare and evaluate a wider class of systems. Since the definition of the conception of probability is itself closely linked to the structural characteristics of systems it is possible to synthesize both approaches in a manner that will explain processes based on principles of rigorous determination on the one hand, and principles of probability on the other.

Still another nonstatistical approach is the *combinatorial* approach which studies finite entities (both stochastic and nonstochastic) while the probabilistic theory is primarily concerned with stochastic sets (both finite and infinite).

Attempts are being made to define the quantity of information for dynamic systems within which there are one-to-

¹ C. Cherry, Op. cit., p. 220.

one relations between cause and effect. In systems of the statistical class on the other hand relations are multi-valued.

A *topological* approach to the definition of the quantity of information is developed in the works of Nicolas Rashevsky, Herman Karreman, and G. Picard who are American scientists. In it the quantity of information is measured in terms of a number of (continuous) topological distinctions.

It should be noted that during the past several years there has been a tendency to go beyond the purely quantitative, statistical analysis of information. This is occurring because regulation systems and particularly regulation systems concerned with social processes cannot be limited by such an approach to social information and require instead that information be understood and subjected to reasoning and that its qualitative characteristics, its meaning and its practical value be identified.

It is therefore not surprising that semantic and pragmatic conceptions are being developed within the framework of mathematical theories of information. Unlike syntactic conceptions which identify formal aspects of systems of signs conveying information, *semantic* conceptions consider not only formal rules but also the contents of information and rules for relating signs to the real objects and real relationships that are denoted by such signs. Since the meaning and content of information is expressed through forms and since real objects and relations are being coded (represented) in formal structures it is then possible to measure the content of information through forms. Of course, in such a context it is not the full contents of information that is measured, but only that part of it which is formally expressed.

Y. Bar-Hillel and R. Carnap who are English logicians and linguists were among the first to develop a semantic conception of information. Their conception is based on purely probabilistic notions that make it possible to consider a model of an extremely primitive formalized language that is quite distant from natural languages. It cannot be applicable to an analysis of the reliability of knowledge expressed in natural languages. And in the case of artificial languages as well, it analyzes only primitive systems and

measures the quantity of information conveyed by the simplest statements and sentences.

Essentially Bar-Hillel's and Carnap's theory is semantic, even though it does include syntactical aspects as well. Neither the relevant aspects of natural languages nor the exchange of information among persons are considered. The quantity of information is determined through Carnap's logical probabilities.

A wider semantic conception is that of Ye. K. Voyshvillo, who is a Soviet specialist in the field of semiotics. This overcomes the purely probabilistic approach of Carnap and Bar-Hillel. In the view of Voyshvillo the quantity of information that is contained in a statement relating to a problem is determined by the extent to which the proof or presumption of truth of that statement reduces the entropy or state of disorganization of a system.

While there exist still other semantic conceptions of information they are neither comprehensive nor of practical significance. The semantic theory of information is currently at an early stage of development.

While there is no doubt that the syntax of a language generally exerts a substantial influence on its semantics, the semantic aspects of information cannot be established satisfactorily at the level of syntax. Nevertheless man's natural languages are so complex, so dynamic, rich, and multi-layered, that it is impossible to apply a precise quantitative measure to their semantic content. Our language is surprisingly flexible and often makes it possible to express thoughts in ways that are not rigorously logical.

It is also true that the language employed for direct communication is not the only one. In particular the language of science, which is formalized to a much greater extent than is the language of direct communication, is playing an increasing role in the life and development of society. Even though there have not yet been many studies of this particular subject it is clear that the language of science lends itself far more readily to information measures of the semantic type.

Appropriate methods for measuring the meaning of information are only beginning to be studied, and in this area there is a search for approaches in which formalization does

not play an essential role. This is very important since the traditional formalized, logical and semantic approach does not seek to measure substantial parts of social information which do not lend themselves to formalization. It would appear that some of the nonstatistical approaches of the mathematical theory of information (namely the dynamic, combinatorial, topological, and algorithmic ones) could be re-examined in terms of the semantic conceptions of information.

A. D. Ursul, a Soviet philosopher, has proposed a semantic interpretation of Academician A. N. Kolmogorov's algorithmic theory of information.¹ An interpretation of information as a minimal length program (algorithm) makes it possible to interpret the quantity of information as the "complexity" or the variety of a program that makes it possible to transform one object into another. The quantity of semantic information that is associated with a sign then expresses the "complexity" of the algorithm that establishes a "correspondence" between the image and the object that it represents. But since the construction of an algorithm (program) is possible whenever the image or object is given, the minimal length of signs expressing operations (commands) may be measured in terms of their variety. A. D. Ursul mentions an example of such an approach to measuring information. If one measures the variety of meaning at the level of words (by assuming that each word is an element and a sign possessing variety, i.e., that each word in a sentence does not repeat another) then the quantity of semantic information will be the minimal length of a sentence (the number of different words) expressing the given thoughts concerning the object. Sentences that contain a variety that exceeds the one that is minimally required are semantically redundant. Such a method for measuring quantitative information is important in transmitting information along communications channels.

One of the advantages of the semantic approach concerns attempts to clarify relationships among receivers and transmitters of information. Because semantic information is

¹ A. D. Ursul, *Informatsiya* (Information), Moscow, 1971, pp. 411-43.

contained in all knowledge that changes the stock of knowledge of a receiver of information, supporters of such a method assert with some justification that the quantity of semantic information that is received is influenced by the nature of the information receiver.

A still deeper and more comprehensive approach to the study of information is provided by the *pragmatic* approach, in which an attempt is made to establish the interdependence between information, the information receiver, and the objectives that the information receivers pursue. In other words the value of information is determined in relation to the person who receives it and utilizes it.

The pragmatic evaluative approach to information is especially important for solving problems bearing on the regulation of social processes, in which not merely any information is required, but only that which contributes to the achievement of the objective being pursued by the system. In such cases identical information may have a different value whenever it is viewed in terms of its relevance to different objectives. A. A. Kharkevich, a Soviet specialist in the area of communications theory, has proposed that the value of information be expressed as a function of the degree of its correspondence to the achievement of specified objectives. The value of information is then determined in terms of the difference between the probabilities of achieving objectives before receiving information and after receiving it. It goes without saying that measuring the value of information through increases in the possibility of achieving specified objectives may be measured only in those cases in which the objective itself is defined with precision.

There exist still other attempts to formalize and measure the usefulness and value of information. They are characterized by a search for a type of formalization in which the logical and mathematical form (structure) in terms of which the information is expressed corresponds to its contents as fully as possible—that is to the structure of the objects themselves to which information relates. It is true that there have not yet been many successes along this path since in such cases the essence of “value” refers to a qualitative property that lends itself to formalization only

with difficulty and even then in only some of its aspects.

The conception of value of information possesses meaning both in relation to the subject utilizing information and to the objectives that he selects.

There is no doubt that the same information possesses a different value for different subjects. It therefore follows that value in this sense is partly subjective since it refers to the objectives, interests, and needs of the subjects utilizing information. This does not mean, however, that information does not possess its own objective value. Any accurate information that is employed in regulation carries with it germs of objective truth and is accordingly valuable in the sense that it contributes to the achievement of the objectives (both proximate and long-term) that a society confronts and it also contributes to social progress.

The value of given information does not remain the same. Should the objective for which it had been used be achieved, the information loses its direct value for the subject even though its value as a quality of given information persists.

The value of information thus emerges as a many-layered characteristic: (a) from the point of view of the subject utilizing it; (b) from the point of view of the internal content of the information itself; (c) from the point of view of the objective that it is proposed to achieve with the help of this information. Since social information is utilized in societies in which different types of social values are inherent information acquires political, ethical, esthetic, and other values both in its theoretical and in its practical aspect.

The pragmatic approach to information presupposes a study of the social relations of individuals, of exchanges of information, and of the goal-oriented utilization of specific information by specific individuals in concrete situations. The pragmatic aspect is closely associated with the semantic one, since associations between signs and the objects that they designate are of a semantic-pragmatic character in the minds of specific individuals who find themselves in concrete situations.

A rigorous utilization of quantitative methods is made possible only through the use of well formalized languages.

It follows that expanded possibilities for applying quantitative methods for studies of the contents of information presuppose either a simplification of the natural languages that are employed for transmitting social information, which is not a realistic prospect, even though it may be possible, or else the creation of formal-logical categories that approximate natural languages as much as possible. It is in the context of the second of these approaches that semantic and pragmatic theories of information are currently developing within the framework of mathematics, even though results so far are very modest and there do not exist as yet any conclusions possessing a practical significance.

In spite of differences that exist between individual mathematical theories of information (syntactic, semantic, and pragmatic) they possess a common element. In the view of C. Cherry this common element rests upon the notion of *selection power*.¹

Shannon's statistical theory views sources of information that produce signals (signs) as systems that make a selection within a set of messages.

In the semantic theory of Carnap and Bar-Hillel the information content of assertions is associated with a selection within a set of states.

At the pragmatic level in situations that are genuinely characterized by communication, information is related to the specific value that it possesses for its recipient: here its value itself may be viewed as a "measure of selectivity".

The principal element that defines the essence of mathematical theories of information is the interpretation of information as the *sublated uncertainty* in such a way that the latter lends itself to quantitative analysis and measurement.

But is it possible to limit oneself to mathematical or more specifically to probabilistic-statistical interpretations of information?

V. S. Tyukhtin, a Soviet philosopher, believes that this is possible: "...The term information carries a genuine load only when its contents correspond to one of the concrete information theories and to the concept of a 'quantity of information' associated with it, as well as to that property

¹ Cf., C. Cherry, *Op. cit.*, p. 244.

of things that lie at the basis of the measurement of information."¹

In our opinion there are no grounds for limiting oneself to such a purely quantitative understanding of information, and even less so to a probabilistic and statistical approach, if only because such an interpretation does not identify the nature and essence of information. Instead it defines information as that which may be measured. But where is the "that" or in other words, *what is information*, and what is the phenomenon that may be measured?

None of the existing mathematical theories provide an answer to that fundamental question.

It is true that in the same work V. S. Tyukhtin states his position more precisely, he first associates the concept of information with the principle of variety and only then with the reflection of variety and of complexity. Yet in both cases he associates the concept of information with already existing mathematical theories and with those aspects of knowledge and of images containing variety and complexity that may be measured and expressed quantitatively.

"...Information," he writes, "is not a special substantive property but rather an abstract aspect of reflection that is associated with objective properties of variety and complexity; 2) all characteristics of an image and of knowledge contain elements of variety and complexity, and for that reason in principle they may be evaluated with the help of a measure of quantity of information."²

It is true, of course, that quantitative and mathematical conceptions of information are valuable both heuristically and practically, but it should be emphasized once more that this is so only within certain limits. In order to calculate the carrying capacities of a channel or the capacities of a receiver or transmitter, or in order to overcome perturbances so as to economize energy in transmitting, storing, and receiving information, it is necessary and sufficient to define and consider only the scope of variety in symbols or

¹ V. S. Tyukhtin, *Otrazhentye, Sistemy, Kibernetika* (Reflection, Systems, Cybernetics), Moscow, 1972, p. 215.

² Cf., *Op. cit.*, p. 241.

various states of the signal carrying information. In such cases it is possible and often necessary to abstract from the meaning and value of information. But this is true only in such a context. In order to utilize information in the regulation of society, on the other hand, it is insufficient to possess quantitative characteristics of that information. A translation of the content of information into the language of symbols and of signals is then required, together with its transmission and reception on such a basis, and then again a translation into a human content-oriented language. It is then necessary to determine its usefulness and value for the user and for the functioning and development of the system. And that, at least at the present time, lies beyond the scope of mathematics.

Information should not be rigorously associated with its quantitative parameters, and one should not view as information only those data that lend themselves to mathematical processing and to quantitative measurement. Such a point of view leads to an exclusion from the information sphere of its greater part and above all of all of social information. And yet such information does exist and circulate in enormous volumes, penetrating our entire lives, labour activities, everyday activities, and leisure, and it influences them in such a way as to help organize social processes rationally by regulating them.

Sufficiently reliable units of measurement have not yet been found for many types of social and especially socio-political and ideological information. We are able to count numbers of published books and newspapers and numbers of pages and characters as well as the duration of radio and television programs. Yet we do not possess the true quantity of information at a given moment in time. In effect information that is contained and disseminated in various types of conferences, lectures, discussions, letters, telegrams, and telephone conversations is not taken into account. Similarly duplicating equipment, ranging from ordinary typewriters to modern photocopying devices, duplicates and disseminates information that also does not lend itself to a quantitative measure, except for a similar counting of pages, lines, and characters. Powerful streams of information originate in various agencies and organizations both at the

central and at the local level, but here again that information is not adequately measured, taken into account, or regulated.

The unit of measurement that is accepted in mathematics, namely the bit, is applied successfully for measuring information that is transmitted along channels of communication and coded in corresponding ways. Yet the very same bit is altogether inadequate, not to say inappropriate, for measuring and evaluating social information, particularly information of a socio-political or ideological character. With the help of a bit, it is not possible to measure the actual significance and value of that type of information and of its concrete elements.

Thus mathematical theories do not provide an answer to the question what is information.

In an article published in the Soviet journal, *Voprosy Filosofii* (Problems of Philosophy) (No. 8, 1973) a Polish scientist Professor Z. Cackowski summarizes this point in the following words.

"It might appear that in considering the meaning of the word 'information' one should turn to information theory. But in fact, information theory is not concerned with that question. It is concerned with the information capacity of specific material systems, the carrying capacity of specific channels of information, with methods of measuring information. As for the nature of information itself it waves this question aside. In the light of the fundamental principles of information theory it is known that information cannot exist or function independently of material processes, but we will not find there an answer to the question 'what is information?'".

But then perhaps that answer is provided by the energy-oriented conception of information.

2. THE ENERGY-ORIENTED CONCEPTION OF INFORMATION

A growing number of authors have taken a critical view of conceptions of information that ignore the energy aspect of its operation and that interpret it as a "non-power" phe-

nomenon. At first sight it may appear that such a view of information may be justified, since even insignificant quantities of energy in signals carrying information may produce greatly amplified responses on the part of receiving systems. This is especially true of social information expressed in words. For we often meet with situations in which a single word or a single sentence acquires a magic influence and brings enormous masses of people into motion. Or else a single road sign may regulate the movement of many thousands of automobiles providing that their drivers accept such signs as law.

Yet it is not without substantial grounds that a number of scientists have taken the position that the essence of information cannot be understood without viewing it as a specific form of energy processes.

Energy interactions occur within nature's nonliving systems as well. But in such cases their interaction is of a simple dynamic character and is governed by the principle that actions are equal to reactions. A fundamental causal determinism then prevails in accordance with which actions correspond to causes.

A different situation exists in the case of self-regularity systems whether they be organic, technical, or social. The mutual interaction of components of such systems, as well as that of the system as a whole with other systems and with its environment acquires an informational character. Interactions in the sphere of information represent a higher type of interaction than do physical interactions. In responding to a weak influence from the outside systems may respond with reactions whose energy capacity may be many times larger than is the signal's energy of activation. The signal that carries information is transformed, and amplified by transforming the free energy contained within the system. A system that does not possess any free energy is not able to behave in an information interaction mode and to amplify signals. Signals thus appear as a specific threshold of quantitative changes beyond which qualitative changes follow, at least in relation to those parameters of the system on which the signal operates.

Interactions among self-regulating systems always constitute an exchange of matter and energy. As for information

itself, it is not some kind of special substance that is able to operate on the system in an autonomous manner as in the case of matter and energy. And in referring to information interactions one has in mind the fact that ultimately they are carried out through specific energy processes that are conveyed by the signal containing information. All this fully applies to the highest type of information as well, namely, social information. Verbal speech and words represent signals carrying the energy of physical oscillations of particles of air. Written words are also signals that carry the electromagnetic energy of waves and electromagnetic radiation. Following their translation through analyzers into the energy of responding centres both the verbal and written word produces specific responding actions on the part of organisms.

Thus in the view of M. I. Setrov, who is a Soviet scientist, all processes that are usually called information processes are in fact energy processes.¹

Basing himself on an energy-oriented conception of information, M. I. Setrov distinguishes the following aspects of information processes.²

1. An amplification effect, which is determined by the presence of free energy within the receiving system, the degree of crisis in its state (in terms of a given parameter) in relation to the external perturbation. The more a system is in a state of crisis, the less will be the energy of stimulation that is needed for its transformation and the greater will be the information value that is contained in such a stimulus. This constitutes a manifestation of the quantitative correspondence between the energy of signals and the energy of reactions.

2. The necessity of a qualitative correspondence between the energy of a stimulus and the reflective energy.

3. The connection of reflection and system regulation process with the information process. The significance of information for a regulation process or else a self-regulation

¹ M. I. Setrov, *Osnovy funktsionalnoi teorii organizatsii* (Foundations of a Functional Theory of Organization), Leningrad, 1972, p. 64.

² Cf., M. I. Setrov, *Organizatsiya biosystem* (The Organization of Biosystems), Leningrad, 1971, p. 123.

process is determined by its "amplifying" character. This means that an information (signal) matching of individual types of energy takes place within systems, whose aim is to bring about a more effective influence on the part of individual subsystems on others.

In spite of the differences that exist between types of information (biological, technical, semantic, etc.), it is the view of M. I. Setrov, they are all based on a correspondence between the power and character of stimulating energy and the reaction energy of material systems and that this constitutes the essence of an information process.

There is no doubt, of course, that information is associated with energy processes, that information interactions can take place only when a specific correspondence between the energy of stimulation and energy of reaction exists, and that in order to transmit information a certain minimum quantity of energy is needed. Yet, to reduce information to energy processes alone is not justified. To transmit information is not possible without energy. But this still does not answer the question *what* is information and *what* is transmitted with the help of the specific energy processes.

Thus the energy-oriented conception, too, does not identify the essence of information. It is not accidental, in such a context, that M. I. Setrov occasionally employs the term "information" in the sense of "communication".

3. INFORMATION, VARIETY AND REFLECTION

A. D. Ursul observes that the existence of nonstatistical mathematical approaches to information that are based on set theory (the algorithmic, combinatorial, topological approaches) has raised the problem of replacing the interpretation of information as an overcoming of uncertainty and of the quantity of information as a measure of the sublated uncertainty. This means that information is not necessarily associated with stochastic processes and that a transition is needed, which is dictated by both logic and practical requirements, from a narrow definition of information as a sublated uncertainty to a wider one as sublated identity.

For these reasons it is proposed to define information on the basis of the *conception of variety*. In such a context the statistical interpretation of information as the sublated uncertainty appears as a special case of such a wider definition.

A. D. Ursul notes that "information in its most general sense is the variety that a given object contains concerning another, and is thus a relative variety. From the point of view of the theory of reflection information may be seen as a reflection of variety, that is as the variety that a reflecting object contains concerning the one that is being reflected (and in such a sense variety appears as a quite general abstract characteristic of reflection)".¹

Already in the mid-1950s W. R. Ashby interpreted the statistical theory of information from the point of view of variety.² While it is the quantitative variety of elements of a finite set that lies at the basis of a combinatorial approach to the definition of the quantity of information, it is the conceptions of identity and distinction that serve as the basis for an algorithmic definition of a quantity of information.

"In order to construct a particular theory of information (mathematical or logical) other ideas must be applied besides the idea of variety, both more general and more specialized. In any such theory, however, the conception of a distinction appears either explicitly or else implicitly as its elementary idea. More specifically this refers to a mutual linkage, mutual transformation, and mutual penetration of identity and distinction."³ A. D. Ursul assumes that the conception of variety on which the understanding of information is based makes it possible to generalize and integrate specific approaches to the definition of information, to forecast the possible development of different theories of information and of their applications and to find a basis for uncovering the relationship between the conception of information and the category of reflection and also other categories of dialectical materialism.

The fruitfulness of the conception of variety for understanding information cannot be doubted. Beyond this it also

¹ A. D. Ursul, *Informatsiya* (Information), p. 153.

² W. Ross Ashby, *An Introduction to Cybernetics*, London, 1957.

³ A. D. Ursul, *Informatsiya* (Information), p. 86.

encompasses, up to a point, the conception of information as a sublated uncertainty and as an ordering and lends a more general form to that conception.

Indeed, ordering is possible only when heterogeneous elements are integrated within a system. It is not possible to imagine even a simple mechanism all of whose parts would be smooth, even and absolutely identical. It is only because the ridges of one part fill the grooves of another or because the axle of a third fits into the bushing of the next that a definite structuring or ordering of a system becomes possible, together with a linkage and mutual interaction of parts as the result of which the mechanism functions in an integrated and ordered manner. It is precisely because of differences and of variety that ordering and mutual exchange among components of a system as well as between the system and its environment emerge in the course of which the system finds in its environment that which it needs for its existence and development. In other words the ordering of a system is largely determined by the informational variety that it is able to assimilate.

Let us also note that the concept of information as reflected variety serves to generalize the concept of information as knowledge and reports.

Knowledge is always the outcome of a reflection of that variety of objects, phenomena, and processes that exists in objective reality. But knowledge acquires a specifically informational character only when it confronts a system with the problem of selecting from a variety of perturbances those that are useful to the system, that reduce external variety and simultaneously expand internal variety. Knowledge and communications that are not understood by a system and that are not assimilated by it (in either a positive or a negative sense), i.e., knowledge and communications that do not convey variety to the system also do not constitute information.

There is no doubt that the concept of information is intimately associated with that of variety and reflection. Yet the concept of information as reflected variety does raise some objections.

In particular, referring to the inadequateness of a definition of information as "reflected variety" M. I. Setrov ob-

serves that "such a definition may not be accepted as accurate: this is because 'information' in this sense always coincides with the conception of reflection, since reflection itself is characterized by a capacity for reproducing certain properties (and hence distinction and variety) of objects operating as sources of influence".¹

It is true that C. Shannon, the founder of the statistical theory of information, has shown that the greater the variety of elements in a transmitting system the greater will be the information that it can transmit. But C. Shannon has also noted repeatedly that neither the variety of transmitting systems nor the variety of systems of signals determine the quality of information and its value and content.

In the last analysis an identification of the concept of information with that of reflected variety leads to the view that information exists in nonliving nature as well since any system of nonliving nature possesses diversity. This has the effect of elevating the concept of information to that of a universal category.

It is true, of course, that the degree of universality of the concept of information is one of the most fundamental questions as well as one of the most debatable ones. In the last analysis the sources of these discussions lie in the concept of reflection since information is intimately associated with reflection, and beyond this is often deduced from that of reflection.

In Soviet literature the understanding of reflection as a universal property of matter is generally accepted. And in such a context authors usually refer to Lenin. Yet Lenin did not in fact make such a categorical assertion. Rather, he expressed the presumption that there is a property quite similar to that of feeling within the very foundations of matter, of inorganic nature. He indicated that science should study such a hypothetical property and uncover in what way that emerging capacity for reflection in nonliving nature is transformed, in the course of a prolonged development, into the property of feeling as defined in living nature.²

¹ M. I. Setrov, *Osnovy funktsionalnoi teorii organizatsii* (Foundations of a Functional Theory of Organization), p. 58.

² Cf., V. I. Lenin, *Collected Works*, Vol. 14, p. 46.

The subsequent interpretation of Lenin's assumption concerning the universality of a reflecting property as a positive solution of that problem has led to serious difficulties in science. The most important one relates to the impossibility of distinguishing between the capacity of inorganic nature to reflect from the usual physical interactions among bodies. In inorganic nature processes of transfers of quantitative relations and structural transformations are inherent in the physical interactions themselves and do not exist independently.

It is only the systems of living nature (plants and animal organisms as well as man), as well as social systems and automated technical devices that can respond not merely to an absolute quantity of energy acting upon them, as in the case of the systems of nonliving nature, but also to relative quantities (signals) operating as impulses (for example, to temporal rhythms and spacial forms) independently of their material nature. It is precisely in that distinction, in the capacity to respond to relations of stimuli (to relative and not merely absolute values) that one finds an objective criterion for distinguishing between reflecting (informational) processes on the one hand and processes of interactions occurring in nonliving nature.

Informational processes occur only in systems that are self-regulating, which are also characterized by a causality of the signal-informational type, as opposed to the physical causality that is characteristic of nonliving systems.

It follows that even though one does find in nonliving nature an objective capacity to reflect that is associated with the mutual interaction of bodies, this is only a *potential* capacity rather than an actual one, since it does not emerge as an important organizational factor.

The systems of inorganic nature are passive and indifferent to actions from the outside. They are not able to distinguish between useful influences and harmful ones, and they do not utilize external influences in order to maintain their qualitative specificity, to improve their properties, and to develop. They do not retain traces of their own history, do not have memories, do not make use of their past experience in the present, and do not forecast their future.

"The leap from reflection in a potential (passive) form to an actual (active) form of reflection refers to a transition from a purely physical causality to a signal-oriented (informational) causality. The latter does not, of course, overcome physical causality, but rather incorporates it as it builds a superstructure over it."¹

The conceptions of "reflection" and "information" belong not to physics but to those sciences that study highly organized systems of living nature and of society. It therefore follows that the nature of reflection and of information may be established only through the capacities of the corresponding sciences.

Physical interactions both among individual components of a system with each other, and between the system as a whole and its environment, exist in self-regulating systems just as in any others. But in the case of self-regulating systems, interactions acquire a specific reflecting function and a capacity to identify the structure of influences and to relate to their variety selectively, that is to select (assimilate) useful influences, ignore neutral ones and neutralize or remove harmful ones which disorganize the given system. Yet self-regulating systems are able to neutralize only some of the perturbing and disorganizing influences, namely, those that do not exceed an acceptable threshold and do not exceed the energy of interactions among system components and thus do not destroy its overall integrity.

A self-regulating system possesses a specific protecting barrier as it were, which allows it to perceive and evaluate harmful factors in its environment that are able to disorganize it even before these factors have entered into direct contact with the system itself. This represents an informational ring, a screen and a barrier that registers and filters signals representing influences rather than the influences themselves. Such signals, moreover, are quite distinct both in terms of their material structure and their energy characteristics, from the perturbing factors themselves and are relatively less powerful. But the central point is that such signals carry information concerning perturbances that is perceived and evaluated by the system's regulating subsystem.

¹ V. S. Tyukhtin, *Otrazheniye, sistemy, kibernetika* (Reflection, Systems, Cybernetics), pp. 87-88.

tem, and that as a result the system corrects its behavior in such a way as to avoid direct contact with dangerous factors in its environment and accept only those influences that contribute to maintaining the system's qualitative specific properties and to achieving the particular objectives that it pursues.

It is characteristic that the signals that are perceived both externally and internally and which carry information and thus appear in the form of information-oriented causality are generalized and analyzed and ultimately transformed into an informational model of the system's behavior in a changed situation. While such a model again represents a set of signals that carry a limited volume of energy, it is nevertheless able, as a result of amplifying arrangements, to activate specific components within the system (or else the system as a whole) whose responses in terms of parameters exceed substantially the corresponding parameters of signals. In this connection one may note the negligible power of nervous impulses and of movements within groups of neural cells that activate entire living organisms.

The fact that within the systems of inorganic nature influences originating in some of them produce specific changes in others does not offer sufficient grounds for viewing them as self-regulating systems. And it is even less justified to interpret such changes as outcomes of signal-processing and of utilizing of information. The systems of inorganic nature do not carry or perceive any actual signals or any actual information. Instead there is the usual physical interactions among systems and the reactions that bring about such interactions. Interactions among the systems of inorganic nature are fully explained by the law of physics and lend themselves to accurate calculations. They are not mediated through either signals or direct or feedback relations of an informational type. Instead the systems of inorganic nature are characterized by specific integrating (system-maintaining) factors, that operate, however, within the context of the laws that govern physical interactions.

Systems of nonliving nature do experience perturbing influences. But they are not able to protect themselves from these influences nor to distinguish between harmful and useful ones. There is no "filter" between the perturbances

and the system and no devices that would analyze the perturbances and distinguish desirable ones from harmful ones. There are, instead, direct influences on the system by environmental factors and this precludes informational stability in relation to perturbing environments. Whenever there is no system activity with regard to perceiving external influences and when there is neither selectivity nor a utilization of influences in the system's interest there are no informational-reflective processes and no signals. Without the latter, however, information may be neither perceived, processed, nor utilized.

The concept of reflection is based on a functional dependence of the reflection or image on its original source rather than on bilateral causal relations that are characteristic of usual physical interactions. In the case of a reflection there is a linkage at the level of epistemology between the reflection and the original source. This is not true of physical interactions in nonliving nature. Such are the principal grounds for asserting that reflection exists only as a potential in nonliving nature but not in an actual form, as a possibility but not an actuality. That possibility is transformed into actuality as nonliving matter evolves into living matter and into the simplest organisms. Physical interactions then acquire a specific reflecting function and interacting physical bodies, separated into original sources and reflections, cease to possess the same direction, and "diverge" into two poles as it were, one of which becomes the original source, influencing the other, while the other experiences the outcome of that influence in the form of a reflection and becomes a carrier of such a reflection.

Both reflection itself and information, which is an outcome of reflection, are selective (constraining) in nature. Specific reflections are constrained in terms of a number of parameters, including the time interval within which the reflection takes place, the characteristics, qualities and properties of the original source that influences the object of reflection, the reflective capacities and state of the reflecting object, its capacity for resolution and throughput and its sensitivity.

The degree of selectivity depends on the scope of information and on its precision. The lower the

selectivity, the higher will be the scope of information while as the degree of selectivity increases so does the accuracy of information.

Selectivity in relation to information increases as biological and social systems develop. A growing diversity of organs emerge that specialize in acquiring and processing information of a particular quality and quantity and in generalizing and synthesizing operations. As its comprehensiveness, diversity, and accuracy increases information becomes increasingly similar to its original source.

Since there does not exist a natural property of reflection and information in nonliving nature, there cannot be any property of regulation either. For regulation cannot be imagined without information in the sense of a continuous briefing of the regulating subsystem concerning the internal correspondence between the object and the environment that reflects it and without activity and selectivity as well as a filtration and evaluation of external and internal influences.

The fact that there are no specific information and regulation processes within nonliving nature does not at all imply that physical and chemical processes do not play a role in the information and regulation processes that occur in biological and social systems. It is sufficient to note that the entire information industry, that is, the system of machines and mechanisms employed in regulating production as well as other systems of a social nature is constructed from materials drawn from nonliving nature. And from the point of view of providing for an effective functioning of such systems, it does matter very much what particular materials are selected and what physical and chemical properties they possess. In constructing memory units, for example, materials are needed that are able to store information in a stable manner (nonreversible materials), that produce a high capacity and density of storage of information for minimal dimensions and that possess high reaction and resolution properties.

The sensitivity of the receptors and sensors of measuring instruments employed in regulation and in information processing depends on the physical plasticity and reactive properties of materials. Accuracy of measurement depends on

the selectivity and resolution capacity of materials. And a capacity for retaining traces of past influences depends on the reversibility and nonreversibility of processes. Similarly the transmission capacity of channels of communication depends on the speed of reactions.

In addition, the processes of physical interaction that are characteristic of nonliving nature serve as the primary genetic material for the reflective and informational processes that take place in living nature and in society. In those systems that are of a higher order, however, physical and chemical processes occur in terms of a dialectical overcoming.

In short, while there is no doubt that information and reflection are related to each other, information is not a universal property of matter just as reflection is not one of its universal actual properties.

Information is neither matter nor energy but is a category of an ideal order. Information is not a thing but a category of thought.

4. INFORMATION, REFLECTION AND REGULATION

What is, then, the relation of information to reflection? Does not the theory of reflection explain the nature of information?

Information is an *outcome of reflection*. In the words of N. Wiener, it is "a name for the content of what is exchanged with the outer world as we adjust to it, and make our adjustment felt upon it".¹

Information is not merely any content of reflection nor any knowledge. It is that knowledge which is *expressed in the communication*. As C. Cherry notes, it represents "informing, telling, thing told, knowledge, items of knowledge, news (on, about)".²

It is impossible to imagine man or society without communications among persons and exchanges of activities among them as well as of products of activities, and of ex-

¹ N. Wiener, *The Human Use of Human Beings. Cybernetics and Society*, London, 1954, p. 17.

² C. Cherry, *Op. cit.*, p. 5.

perience. This necessarily acquires an informational character in the sense of an exchange of news and knowledge concerning the most diverse aspects of natural and social reality. Accordingly, the fact that the conception of information as communication and knowledge has been firmly accepted in science and practice is by no means an accident. It is interesting to note that the conception of information as knowledge appears as a link between the synthesizing view of information as reflected variety and the view of information as ordering. Knowledge and communication represent an outcome of the reflection of variety in natural and social reality, on the one hand while on the other they contribute to the increased ordering of a system and to an increase in its internal variety. The dialectics of the movement of variety within informational-reflective processes is thus a movement from external variety, referring to the objects influencing the system, towards a variety of images in the sense of knowledge and communications, and from there to the internal variety of the system.

At the same time, information is not merely an outcome of reflection and not merely knowledge. It refers to communications and news, i.e., to needed knowledge and to knowledge for which there is a user. As it interacts with its user, knowledge acquires the characteristics of a communication and of news, i.e., becomes information. *Information refers to that part of the knowledge that is utilized for the orientation of systems, their active operation, and their regulation, i.e., in order to maintain their qualitatively specific properties and to improve and develop them.* This is knowledge which is constantly moving and circulating. It is knowledge which is collected, stored, transformed, transmitted, and utilized (or else may be utilized) by a system. In short, information is that part of reflection and knowledge which "carries out work".

Of course this does not imply that this is the only part of reflection that is encompassed by information. For information also includes another part insofar as it is associated with practical activities. That relation however is mediated through a series of "engineering" designs that may monitor the acquisition of knowledge for as long as one may wish. Thus information emerges as both an element that is actual

and directly associated with the practical activities of regulation and as an element that may serve practical requirements effectively but only in the future or else in principle, even though it may perhaps never be used.

The concept of real (actual) information encompasses not any knowledge and not any communication but only that which is accepted and utilized for purposes of orientation (self-regulation) or else for purposes of influencing a particular object (regulation).

Academician A. N. Kolmogorov associates information with processes of management and regulation carried out by living organisms (either consciously or unconsciously) or else by automatically operating machines.

Yu. I. Chernyak, a Soviet specialist in the field of automated control systems, states that it is possible to refer to information only in those cases when an object or a phenomenon for which a system is being designed is first identified within the external world, when the position of the observer (researcher, planner, manager) is established, and when the task that is to be served by research activities, planning or management is clearly formulated.

In other words one may refer to information only when the object that is the source of information is known, when there is a person (agency) interested in information concerning that particular object, and when the user receives information and data not in some general manner such as, for example, in satisfying curiosity, but for resolving either research tasks or managerial tasks.

Following an analysis of existing conceptions of information I. I. Grishkin, a Soviet philosopher, observes that one finds two approaches to a definition of "information", namely:

an attributive approach in which information is described as a property of moving matter that refers to the structuring, ordering, variety, and organization of its state;

and a functional-cybernetic approach in which information is viewed as a property of only self-regulating and self-organizing systems.

The author analyzes the first of these approaches critically while developing the second approach in a comprehensive manner. It is his view that an adequate understand-

ing of the nature of information leads to its interpretation in semiotic terms. This requires that a unity of syntactical, semantic and pragmatic aspects must be taken into account at the level of self-regulating and self-organizing systems. In such a context I. I. Grishkin distinguishes the following aspects of the concept of information:¹

(1) The complexity of the concept of "information", which refers to the presence of a syntactic, semantic, and pragmatic aspect in its contents;

(2) The unity and specific characteristics of these aspects;

(3) The "explicitating" nature of the concept of "information" which refers to the definition of quantitative measures of syntactical, semantic, and pragmatic information;

(4) The metatheoretical character of the concept of "information" which refers to its application in evaluating scientific knowledge, theories and methods;

(5) A cybernetic interpretation of the concept of "information" which represents in an abstract form the general features of informational processes within self-regulating and self-organizing systems.

The conception that associates information with regulation is by no means immune to criticism. For example, is it possible to exclude unutilized knowledge from information even though that knowledge may be stored and transmitted and may represent information in that sense? Is it necessary to always include an application of reasoning to processed information, since in the case of computers, for example, information, while being processed, is by no means subjected to reasoning?

But on the other hand, are these difficulties really insuperable? It would seem that some of them may be overcome by distinguishing between the concept of "information" and the closely related concept of "information data". Data include all briefings, communication and knowledge. They may be stored, transformed and transmitted but they acquire the character of information only when they receive a content and form that is suitable for regulation and when they are employed in regulation. This includes, moreover,

¹ I. I. Grishkin, *Ponyatiya informatsii* (The Concept of Information), Moscow, 1973, pp. 155-56.

both the regulation of man by himself and the regulation of man-machine systems and social systems at various levels.

In fact such a point of view is well accepted in the concept associated with programming computers and with automatic data processing, as well as in economic semiotics, where "data" and "information" are viewed as closely related and mutually linked yet distinct conceptions.

In this connection let us cite the somewhat extensive yet quite convincing considerations of two American specialists R. G. Murdick and J. E. Ross, concerning the distinction between the terms "information" and "data" and their relation to each other: "Because *information affects the behaviour* of men or machines, a useful distinction may be made between data and information. Data may be considered signs, usually recorded observations, that are not *currently* affecting behaviour. However, data may *become* information if behaviour becomes affected. For example, the data base for computer systems consists of masses of such signs that are not affecting behaviour. Until the data are actually viewed, and properly organized for a manager so that he reacts to them, they are not information. To put it in decision-making terms, it may be said that information is *data in use*. . . . This concept is important to remember in the design of MIS (Management Information Systems—*Ed.*) because data must be delivered to decision makers as information to be acted upon.

"The problem with most so-called information systems is that they are treated as *data* systems rather than *information systems*."¹

A number of authors note the importance of taking into account the different conceptions of information and the homonym of the term "information". It is important that each conception contribute to an understanding of the surrounding world from the point of view of gaining power over its forces. We wish to associate ourselves with such a position, while preferring an understanding of information as the reflection and knowledge employed for practical activities and control.

¹ Robert G. Murdick, Joel E. Ross, *Information Systems for Modern Management*, Englewood Cliffs, 1974, p. 315.

CHAPTER II

THE ESSENCE AND FUNDAMENTAL CHARACTERISTICS OF SOCIAL INFORMATION

In order to clarify the role of social information in regulation it is necessary to identify its essence as well as its specific characteristics.

1. THE ESSENCE OF SOCIAL INFORMATION

Information that is employed in the regulation of social processes constitutes *social information*. It represents knowledge, communications, and news about the social forms of movement of matter, and concerning all its other forms, in so far as they are employed by society and enter into the orbit of social life. This refers to social information in the *wide* sense of that word, that is to information that circulates *within society* and passes through the consciousness of men.

Man forms and utilizes social information and is both the principal object and subject of regulation activities. He is a social being in his very essence and inevitably belongs to a particular society, class, nation, collective. Social information carries within itself deep traces of class relations, national relations, and other relations as well as marks of needs, interests, and psychic traits of the collectives to which information relates and which employ information. It is in this that we find the main essence of social information, as well as the watershed that divides social information from all other types. This type of social information refers above all to relations among persons and to their mutual inter-

actions, needs, and interests, and it refers to social information in the *narrow* sense of that word, to information reflecting *relations among persons*. This is social information proper.

The information processes that take place in society cannot be attributed to autonomous causes, nor can increases in the volume and variety of information. These processes are determined by the system of social relations and above all by the development of production. It is true that within such a context there does not exist a unique type of dependence, and that it is difficult or impossible to establish specific quantitative proportions. An exception is provided by economic information, which appears to be increasing in proportion to the square of the rate of growth of the number of enterprises and the quantity of output. Nevertheless, such a dependence does exist, just as there does exist a feedback influence of information on production and on the system of social relations. Informational interactions among different spheres of social life, classes, social groups, and individuals constitute an extremely important and specific form of social interaction. Progress in production, science, technology, culture, and society as a whole largely depends on the effective and rational organization of informational interactions. Similarly, the relative effectiveness of such interactions represents an important indicator of social progress.

The influence of society on informational processes is clearly apparent in the *class approach* to information in society. This influence is by no means indifferent towards the contents, purpose, and utilization of information. The attitude of classes and of society to different types of information naturally varies as does the influence of society itself on different types of information. Information pertaining to the natural sciences and to technology does not contain explicit class motives for example, and a class orientation attaches to it indirectly through the objectives for which that information is employed. In the context of capitalism, science and technology, and hence scientific and technological information are ultimately employed to obtain capitalist profits and serve as a means for exploiting workers, while in a socialist society they serve the labor activi-

ties of man and represent a means for satisfying his needs and the development of his abilities.

Socio-political and ideological information, on the other hand, is a different matter. It cannot avoid being of a class nature. A "pure fact" taken from the sphere of social life is no longer neutral. It is selected from the point of view of a class position and is expressed in a form that corresponds to such a position.

Bourgeois sociologists seek to prove that social information relates to a context that is wider than that of a class and a party and that it centers on man himself. Two chains of reasoning are usually adduced in order to support such a view.

In the first it is noted that there exist universal laws, methods and forms in developing, processing and also transmitting information, as well as common technical equipment for processing information.

The second argument notes that since information is objective it cannot be of a class or party nature and that an orientation on party objectives therefore constitutes a renunciation of objectivity and of the scientific character of information which are then sacrificed to class needs and criteria.

Let us consider these two arguments more closely.

There is no doubt, of course, that there are many general elements in the methods and techniques of information processing which do not depend on the nature of the society within which that work is carried out and on the class that carries it out. These general elements, in fact, are so extensive that a variety of grounds do exist for envisaging the possibility of developing social cybernetics as a specific science.

Yet the technological aspect of information processing is only a part of the overall informational process and by no means the major one. Its general non-class character does not offer grounds for asserting that entire informational process, too, is of a non-class and general nature for the whole cannot be represented in terms of one of its parts. Beyond this the parts themselves are shaped by the whole, and this means that in the final analysis the technology of information processing itself serves the achievements of

those objectives that a class and society places before itself in organizing the informational process. Does not the sophisticated equipment that is employed in mass communications media, for example, serve the objectives of the bourgeoisie?

As for the second argument it is intimately linked to the first. The objectivity, truthfulness, and scientific nature of information again depend on the nature of the class that develops it and utilizes it, and on the nature (progressive or reactionary) of the society that it serves. Within a socialist society information serves the working class and working people who are interested in a truthful and objective reflection of social life, since the objective course of history contributes to their interest. The interests of the bourgeois class in a capitalist society, on the other hand, stand in opposition to the requirements of social progress, and accordingly the bourgeoisie finds it necessary to sacrifice truthfulness and objectivity in information in serving its interests.

An emphasis on the psychological aspects of information is relatively widespread in bourgeois sociology. In that connection it is asserted that although information itself is neutral, different persons perceive it in different ways. And this is because the perception of information of each person depends on his subjective conceptions and also on his orientation on the opinion of other persons. This neglects the fact that even though the conceptions of a person may be subjective, they are *determined by his position within production and within a system of social relations*, and last but not least, by his membership in a particular class. Nor are the opinions of other persons autonomous. Public opinion is created by society and by the ruling classes in particular societies in relation to their own image. In such a context information and mass communications media play a large role in its development.

Marxist sociology studies information as a social phenomenon and views it in the context of a unity of all its components and from the point of view of those class objectives and social tasks that it serves. Social information and above all its ideological component constitutes an important instrument in the struggle of classes.

2. THE HIGHEST TYPE OF INFORMATION: GENETIC AND SOCIAL HERITAGE

In the wide sense of that word, which refers to a reflection of social relations and interactions of any type and at any level, social information is *the highest type of information, whose complexity and variety is greatest*. Above all this is because social information is employed in society, which is itself the highest form of movement of matter. It is employed by persons in the context of a purposeful influencing of society, in short, for the guidance and regulation of society, and this represents the *highest type of control*. No other type of information is subjected to such a comprehensive and many-sided processing and is employed in such a variety of forms.

Man is the principal component of any social system at any level. Because man is a social being, his qualities as a social being are produced by the society and the social relations within which he lives and develops. Yet the social element in man did not emerge and develop suddenly or autonomously. It was based on specific *biological prerequisites*. While at the present time the social elements have developed intensively and constitute the deepest essence of man, man remains a biological entity, the highest organism. Man is thus a unity and interaction of biological and social elements of which the social constitutes a foundation. The social element in man negates and "overcomes" the biological element dialectically.

But to negate or "overcome" does not, of course, mean to completely destroy. A biological element is the necessary prerequisite for the emergence, consolidation, and development of the social element. In particular, social production, that initial historic act which has given birth to man and to society, has emerged as a result of a need to satisfy specifically biological needs of the human organism. And only later, much later, in fact, did the sphere of his spiritual and specifically social needs develop and continually expand, whose satisfaction is again based on biological needs. In short it is impossible to conceive either man himself or society outside his biological context. Man needs food, clothing, housing. These are his biological needs and it is under

their direct influence that social production develops, which itself serves as the basis for all social life. Society has produced the family which reproduces mankind and together with it the entire system of social relations. Even such a refined and specifically human sphere as spiritual life cannot be imagined without biological foundations, namely the organs of perception through which the external world and the internal world enter into man's mind where they are transformed into the most complex spiritual categories.

It is well known that control processes are constitutive elements of biological systems—in plant and animal organisms. In particular I. P. Pavlov, the prominent Russian physiologist, has observed that organisms represent systems that are "highly self-regulating, self-sustaining, and renovating, self-correcting, and self-improving".¹

Just as the biological element has served as a prerequisite for the social element in man, biological control processes have served as prerequisites for social control processes.

One finds in man all the characteristics of the biological system generally, including metabolism, irritability, capacity to grow, changes and heredity, development, and aging, as well as biological control processes that provide for the protection of these characteristics and hence, for the integrity of biosystems.

Just as one cannot imagine a social form of movement without a biological form, one cannot imagine social control processes without biological. Yet just as the biological in the social is subordinated to the latter, so are biological control processes subordinated to social control processes, which they serve.

Having emerged on the basis of biological control processes, social control processes did not become altogether distinct from them but rather "overcame" them in the dialectical sense and have lent them a social essence by placing them at the service of social elements. Above all attributes of social control processes are associated with consciousness and with a conscious influence by man on both himself and on the environment within which he works and lives.

¹ I. P. Pavlov, *Collected Works*, Moscow, 1951, Vol. 3, Book 2, p. 188 (in Russian).

In one way or another these are absorbed by biological factors since social control processes can be carried out only in the presence of normal biological control processes which provide for an effective maintenance, improvement and development of man's organism.

In spite of the common features of biological and social control processes, however, there are also qualitative distinctions between them.

It is not our task to consider all of them, and we will merely note one of them that is particularly important in the context of the issues that we are considering.

This refers to the *information basis* of biological and social control processes.

In the case of animals, their behavior and influence on the environment is primarily programmed through *genetic* information transmitted from generation to generation through heredity. Living nature has not achieved much with regard to the exchange of information obtained in the course of a lifetime, with the exception of the mechanisms in which an imitation of the behavior of species of the older generations serves species of the younger generation as a primitive exchange of signals that warn about dangers and certain other changes in a situation. It is true that there do exist highly integrated associations within the world of animals as well, and yet the integrating factor is then provided not by information acquired in the course of a lifetime but rather by the dominance of "rigid" information acquired through heredity and representing a program of behavior.

Social regulation is based on altogether different informational foundations. There it is *social information*, rather than inherited information that plays a decisive role. A specific system of information that is *supra individual* in character provides for the accumulation, storage, and transmission of vitally important information that then programs the behavior of individuals from generation to generation (vertical exchanges of information) and also causes exchanges of information among persons belonging to a single generation (horizontal exchanges of information).

Academician N. P. Dubinin, a Soviet geneticist, has stated that the uniqueness of the *Homo sapiens* species is de-

termined by the circumstance that unlike animals, that species possesses a second program in addition to the genetic one, which was made possible by the emergence of consciousness and which also determines its further development in each successive generation. This second program may be called a social heredity program.

This second specifically human program is based on social information. And as the basis of man's biological and genetic evolution the genetic program plays its own role in the development of both man and mankind. Yet genetic evolution merely provides the material, and the substratum for the social evolution that takes place over time in a manner that is essentially independent of man's genetic evolution. In particular the immense transformations that mankind has experienced over the millennia of written history were not accompanied by any noticeable changes in man.

It is assumed that *Homo sapiens* have existed for approximately 40-50 thousand years. During that very long period of time, when viewed from a historical perspective, the biological nature of man has not experienced any perceptible qualitative changes. The capacity of man's brain has not increased, his heart continues to channel blood into the same direction and the volume of blood that it circulates is not appreciably greater. Similarly man's sensory organs and the emotions that are characteristic of man have not changed during this period in any perceptible way.

During that same period of time, however, the social element in man's life has changed beyond recognition and is continuing to change rapidly. In evaluating man as a social being the personalities of a slave and of a slaveowner, of a serf and of a feudal landowner, of a worker and of a bourgeois and finally of a socialist person, represent the principal points of reference that also correspond to the basic stages in the movement of society from the slaveholding stage through feudalism and capitalism to socialism. And all this has occurred over a period of "merely" several thousand years.

In the history of mankind genetic and social information streams flow independently of each other. It is only in the process of the life and development of an individual that

they meet each other, cross each other, and interact with each other.

Indeed, the genetic information that is received by each newly born person contains only a possibility of his transformation into a human being. But that possibility is transformed into actuality only when that individual assimilates social information in the course of a process of socialization, together with the experience and the knowledge of past and contemporary generations that it contains. The outcome of social progress is not encoded in the genes. It is transmitted only through social heredity.

Above all it is that social information which is embodied in instruments of labor and in other objects of "second nature" which constitutes "social heredity". It includes social information embodied in documentary forms (books, newspapers, journals, magnetic tapes and discs, archives) as well as in the form of artistic images (works of literature and art) and in verbal form. This is precisely the reason why each new generation is able to inherit earlier achievements in the field of production and in socio-political and spiritual life, and is spared the necessity of repeating everything from the very beginning. By proceeding beyond what has already been achieved, it is able to attain new successes in various spheres of society.

Aside from information that is received as a result of social heredity a specific part of the information stock of each specific individual is made up of *lifetime information*, i.e., of knowledge and news that each individual receives as a result of direct contact with both his natural and social environment. In short, this refers to information that is the outcome of the *personal experience* of individuals, which, together with information that is borrowed from mankind's general information stock, explains the specifically personal character of the thinking and behavior of each individual and his specific capacity for orienting himself within the surrounding world and for influencing that world, i.e., for regulating himself and for influencing the circumstances within which he exists.

All this does not imply, of course, that the genetic information received by each individual is identical, nor that individuals interpret the influence of their social environ-

ment and assimilate social information in identical ways. The stock (volume and content) of each person's genetic information is unique, and this accounts for the individual and specific character of his interpretation of influences from his social environment, as well as the forms, rates and degree of comprehensiveness of his assimilation of social information. The influence of the social environment and the assimilation of information operates through the internal world of individuals, where genetic factors, too, occupy a tangible position. It is such internal elements and specific elements of heredity and of hereditary information that serve as the ground from which those shoots of social information emerge that then shape the transformation of individuals into men and members of a society.

Georg Klaus, a well-known German Marxist philosopher, observes that in terms of cybernetic terminology genetic information establishes the nature of the strategic rules of gaming that govern relations between man and his natural and social environment.¹ The general heritage of the species called "man" constitutes a large part of this information. Precisely this information makes it possible for him to separate himself from the surrounding world, to orient himself within it, and to regulate his own affairs and behavior in a very general manner that is independent of his individual characteristics. It serves as the basic material common to the entire species for conveying that externally developed and also personally acquired information which ultimately defines the social characteristics of man.

One of the important distinguishing characteristics of biologically acquired genetic information, as opposed to social information, is that for a given population genetic information is transmitted inflexibly from generation to generation through the corresponding cells. Social information, on the other hand, is renovated for each generation. If one does not educate and train individuals, in short, does not convey to them information at the level of contemporary culture, they will immediately begin to resemble their distant ancestors. It is only through the re-creation and re-

¹ G. Klaus, *Kybernetik Gesellschaft*, Berlin, 1964.

production of information developed by preceding generations and through the assimilation of information available to his contemporaries that man becomes a man and a social being.

Experiments have shown that normally it is only in the context of a continuing informational exchange with the surrounding world that man is able to think over prolonged periods of time.

Information operates as an active influence on the consciousness of persons as well as on their behavior. That influence, moreover, is not always direct and observable. It frequently operates in a hidden manner, as unnoticed quantitative changes accumulate within the consciousness of men that ultimately bring about fundamental qualitative shifts. Information that has been consciously selected in a goal-oriented manner possesses an important capacity to convince, and is thus able to cause significant changes in ways of thinking, in the opinions of individuals, and hence in public opinion as well. Accordingly, it is able to produce views and forms of behavior on the part of individuals that correspond to social requirements.

Within the context of production activities, in social life, and in everyday life persons enter into a diversity of relations with each other that are conditioned by their position within the system of social production, by the nature of the labor activities that are being carried out, and by their position within their society's social structure as well as by their sex, age, and place of residence. These relations have a close reference to informational interactions among persons, classes, social groups, and collectives, i.e., with the collection, storage, processing, transmission, and assimilation of information.

The functioning and development of society as well as the existence and development of each individual person thus require informational linkages, and informational interactions, i.e., a continuous exchange of information and of news concerning various phenomena and processes taking place in reality in order that individuals may carry out their social role effectively, and regulate a multiplicity of objects in the surrounding world as well as collectives of persons and themselves.

3. ADDITIONAL OBSERVATIONS CONCERNING THE SPECIFIC CHARACTERISTICS OF SOCIAL INFORMATION

There is still another reason why social information represents the highest type of information. This is because it derives from *social practice*, which is the highest type of transforming activity, and because it contributes to practice. Because social information exists in the form of conceptions and categories within the consciousness of men it cannot exist outside of practice.

In the article that has already been cited Z. Cackowski writes: "The following is our thesis: outside and independently of man's practical activities it is impossible for the information that appears in the form of man's psyche (i.e., social information—V. A.) to either emerge or exist."

If one also considers the fact that active reflection is not possible without regulation processes, while without active reflection, information itself cannot exist, there is every reason to conclude that social information, active reflection, and social regulation are all intimately associated. It is as a consequence of reflection that information emerges in practical activities and especially practical activities associated with regulation (of means of labor, and of natural and social processes) and ultimately serves practical activities, especially practical activities associated with regulation.

Labor and productive activities have played a decisive role in the developments of man's capacity for understanding and for a conscious and goal-oriented acquisition of information concerning both his natural and social environment. It is in the course of labor activities and above all while producing and utilizing the instruments that he has placed between himself and nature that man has perfected his capacities for reflection and for receiving and accumulating information. As progress occurred in the field of production, science and technology and social development, an increasing range of the most diverse objects and phenomena entered into the field of his reflective activities and man learned to understand more fully and in greater detail both

the larger entities that these objects and phenomena constituted and the objects or phenomena themselves.

Man's reflection of the variety of nature and information concerning natural phenomena guides him in those of his practical activities that are concerned with the creation of artificial variety—that endless and continually increasing and diversifying world of “second nature” which is acquiring a growing significance both as a source of information and as a means for storing, transforming and utilizing information in seeking to preserve and perfect society and to regulate it. Man's informational possibilities expanded considerably when in addition to artificial means of labor he began to produce artificial signs to denote the variety of natural, artificial, and social nature. The production of means of labor, and progress in production generally served as a basis for the production of signs, which increasingly came to play the role of signals permitting both man and social systems to orient themselves within the increasingly complex world of nature and of society and to organize the regulation of natural and social processes.

Z. Cackowski distinguishes three levels of social information, depending on the nature of its relation to practical activities.

The first level refers to observed information that emerges in the context of practical activities and which itself serves practical activities directly. Its source lies in that sphere which is accessible to observation as well as to man's practical activities. Man is related to that sphere through a two-sided material and sensory linkage. He is able to both perceive it and influence it.

The second level refers to information that reflects the sphere of one-sided sensory perception. While it is accessible to observation it lies outside the sphere of man's practical operations.

The third level refers to information reflecting a sphere that currently serves as an object of theoretical considerations, rather than of sensory perception or of practical activities.

Each of these levels relates to practical regulating activities in different ways, both in guiding them, and in serving their operations.

The first level, as has already been noted, serves practical activities directly, while the two other serve them only indirectly. Both the second and third levels possess an informational value but this depends on either direct or indirect linkages with information of the first level and hence on its linkage with practical regulation activities. In short, information from the first level, which is directly related to practice, serves as the basis for information from the other two levels.

Another reason why social information represents the highest type of information is that its contents consist of the product and result of *logical thought*, which represents the most active and the highest type of reflection of reality.

Social information does not lie outside of matter. It cannot be imagined without its source, namely, material reality and without the variety that it reflects. It cannot be imagined without a material substratum, namely, the human brain which produces it, stores it, transforms it, and utilizes it. Nor can it be imagined without a specific material carrier, i.e., the material form in which it is embodied and that makes possible its development, storage, transmission and utilization. This form refers to both natural and artificial languages. It has already been noted that it is also not possible to imagine social information outside the context of social practice, which rests on a material foundation. Social practice operates both as the basis for its emergence and as the object that social information then serves. Both in terms of its essence and of its content, however, social information is ideal.

In this connection, we wish to express our disagreement with views that refer to the dual (material and ideal) character of social information and to the transformation of material information into ideal information as well as the reverse.

Thus, A. D. Ursul, for example, asserts that mass communications media (radio, television, publications) transmit ideal information to anonymous receivers. But since, as a rule, technical means are employed for transmitting communications, ideal information is transformed into material information. Yet, as communications are transmitted, information remains social and human (ideal) both when it

is stored in the minds of men and when it is recorded on a magnetic tape or some other material carrier and also when it is transmitted in coded form along communications channels. For without altering its ideal content this merely changes its form of expression, which is, moreover, always material. Information is entered in the form of verbal speech into a radio microphone, is then transformed into electromagnetic signals and transmitted in a coded form, while after decoding it the receiver conveys it to the listener once more in the form of verbal speech. Yet, speech (both written and verbal) is a material carrier of information. Numbers, codes, symbols, physical signals, and technical equipment are also material carriers of ideal information. No matter what the extent of its ideal character may be in the context of society, information is always developed, transmitted, and perceived in material forms and through its material carriers.

Nor are there any grounds for assuming that ideal information is transformed into material information through the process of labor, when the knowledge of persons is embodied into the objects of "second nature". For while it remains ideal in its essence, information is then merely re-coded and embodied in different material forms. This includes different types of designs, plans, objectives, and the corresponding forms of words, graphs, and formulas. The corresponding objects of "second nature" include such forms as machines, mechanisms, and structures. In order to retrieve information from objects of "second nature" it is again necessary to turn to some language (either natural or artificial), for outside the context of languages man is not able to perceive information.

It is therefore not possible, in our view, to speak of transforming social information from a material form into an ideal one, for as a reflection of social processes within the consciousness of man social information is always ideal.

Man is the producer, storer, transformer, and user of social information. He is a being possessing a specific human psyche which influences very considerably the character of information.

Man's consciousness reflects each object that he identifies within reality both in terms of unique images that

embody specific properties of such objects in a sensory form, and at the level of general properties, noting the object's family attributes and embodying them in a conceptual form. Such a two-level approach is also one that is essentially unified, even though it encompasses clearly distinct layers of a perception of reality. This makes human information especially valuable for practical activities, particularly for regulation. The identification of common properties makes it possible to establish laws of behavior and trends governing the movement and development of real systems and to subsequently make use of them, once they are established, in order to influence consciously entire classes of homogeneous systems, which are frequently very large. Similarly, a capacity to identify individual and specific elements of concrete systems makes it possible to take their individual characteristics into account in the course of regulation.

Social information is embodied in concepts that serve as effective reducers of variety. As information penetrates into the essence of systems it moves from greater variety to lower variety. This fully corresponds to the essence of regulation, whose main objective is to limit the variety of possible, practical influences on a system and to select an alternative that leads to a specified objective in the best possible way.

The conceptual form of social information makes it possible to reduce very substantially the volume of information that is needed for making decisions. It frees the subject of regulation from a need to identify all the properties of the object or process that perturbs the given system either from outside or internally. After establishing only some of these properties the subject enters the perturbing activity into a specific class and associates it with a definite conception, which then guides him in carrying out regulating activities. In this connection V. I. Kremyanski, a Soviet philosopher, writes that "In a general sense it may be said that conceptions serve to concentrate information. Moreover, they also 'order' it and organize it within themselves. They identify unity in situations which at first appear to represent unrelated variety, in the words of A. Einstein, as well as various distinctions within what appears to be some-

thing unified. . . . In other words, conceptions also serve external organizing activities. These are the functions of organizers".¹

The information that is contained in conceptions is quite different from that which is studied in statistical information theory. That theory considers only additive sets of acts concerned with selecting constraints on some undefined variety in order to translate it into a discrete and defined variety. In the case of conceptions, on the other hand, because their information is no longer dispersed and unordered, it acquires system-oriented properties as well as organizing and organized properties.

Regulating activities are also served by still another specific property of man's psyche, namely his *capacity to project*. This refers to the capacity of consciousness to distinguish the contents of subjective images from the objects themselves. It is this property which "liberates" the psyche from a rigid association with reality and makes it active, permitting it not only to reflect that which exists but also to carry out anticipatory reflections and to plan and forecast the course of social events. It is precisely such a capacity to foresee that provides one of the major features of regulation.

Social information possesses the most highly perfected universal storage facility, namely, *human memory*, which like overall consciousness itself, is social in terms of both its origins and its essence. Human memory is able to record information, to store it in the form of specific traces, and to reproduce it within consciousness. The recording of information in human memory constitutes essentially a vertical transfer (over time) from the past, through the present, and into the future. But memory is also able to convey information horizontally (in space), from person to person, by storing it in the form of language.

The human brain, which is the highest product of matter and the most perfected of nature's creations, operates as a substratum of memory in the storing of information. It dif-

¹ V. I. Kremyanski, *Ponyatiya giperstruktury i sistem informatsii v biologii* (Conceptions of Hyperstructures and Information Systems in Biology). In: *Filosofskiyе problemy biologii* (Philosophical Problems of Biology), Moscow, 1973, p. 192.

fers from the memory substrata of other living organisms and from technical devices through its complexity, the variety of information that it stores, and its capacity to form models of the problem situations in which man finds himself.

The principal informational characteristics of human memory include the following: a capacity for an ordered storage of information concerning individual experience; the existence of several types of remembering (short-term and long-term memory); an hierarchical organization of the impressions that are stored in memory and the formation of time-oriented linkages, images and impressions that are stored in memory; the participation of memory in processes of learning, perception, extrapolation, and heuristic thinking; the reordering of information in accordance with the contents of current experience (an associative regeneration of stored information); the existence of chains of feedback relations between memory and sensory organs and of feedback control activity on the part of memory with regard to perception processes; structural and informational reliability in long-term memory; and a programming by memory of regulation processes taking place within the organism.

It is evident that neither biological memories nor electronic memories possess the comprehensive range of information characteristics of human memory.

Social information is not simply knowledge that is recorded in human consciousness. Rather it is that knowledge which *brings changes into that consciousness*, and which is utilized and psychically experienced either in the context of developing and taking decisions or in the form of particular emotions.

There is unquestionably information within social systems that does not pass through consciousness and does not represent an outcome of the reflection of the variety of nature and of society in the human brain. Man either does not suspect the existence of this type of information, or else does not possess sufficient scientific and technical means in order to acquire it. Such information (which is hidden and not employed by man) should be called *potential information*, in order to distinguish it from actual information that is employed by man.

It should be noted that a number of authors have expressed such a point of view in relation to biological systems and have described such information as "information within itself", or potential information, while biological information that is the outcome of "the reflection or else programming" of a structure and is transmitted along communication channels, is called free information.

Something analogous to this exists within social systems. There, too, appears to exist tied or structured information that is neither extracted by man nor utilized by him. It represents a potential for information that is contained in any object of human culture (such as means and objects of labor) that are not specialized in carrying out informational functions. In contrast to this, the information that is already extracted and that represents reflections in the minds of men of objective processes taking place in nature and society and is utilized by them represents free information.

Interactions among social objects are not always reflected and identified in human consciousness, and there exists a class of interactions that does not pass through human consciousness. While such interactions do influence the consciousness and behavior of man, of social groups and of classes and do operate as factors of regulation, they do this as elemental factors that do not pass through the consciousness of men and are accordingly not taken into account in their practical affairs. It is only after they have been reflected in consciousness in the form of ideal images, such as theories, laws, categories, and scientific conceptions, that they acquire the character of actual social information and serve man and his social institutions as a conscious regulation factor.

Audible or visible words are the material carriers of social information and the signals that carry it. Speech represents the highest type of known signals ("the signal of signals", in the words of I. P. Pavlov). The word is that universal signal which makes it possible to embody the logical content of human social information into a material form which makes it possible to be received, stored, and transmitted, and to be applied by persons in their diverse activities, including control activities. In such a context it is not important that the contents of information employed in

control activities are frequently encoded in order to permit their processing by digital or else analogue computers in the form of signs and symbols. For ultimately, they are employed by man in a decoded form, that is in the form of visible or else audible words that are understandable to man.

In nature, on the other hand, there do not exist, nor can there exist, signals in the form of speech. In this connection, C. Cherry observes that "Mother Nature does not speak to us in language or vary her 'signs' to assist an investigator in interpreting her 'message'." Man does not receive from nature any signs or signals that constitute a physical embodiment of communications, and receives neither words nor images and symbols. "The 'stimuli' received from nature—the sights and sounds—are not pictures of reality but are the evidence from which we build our personal models, or impressions, of reality." Nature does not select the signs to suit our particular difficulties of observation.¹

It is true that in systems of a biological order a specific natural code is employed in passing from one level of signal processing to another, namely, one that is based on neurophysiological frequencies. Such codes appear to be more suitable for translation into discrete formations of continuously modulated signals.

As human societies appear, the neurophysiological methods of coding information that are characteristic of living nature are transformed into systems of language signals and languages are used to convey signals. Subsequently natural languages serve as the basis for the development of artificial languages and the development of sign systems that makes it possible to amplify information processes and to reflect in information new and increasingly comprehensive and multifaceted properties of natural and social reality.

The use of words to convey signals makes it possible to pack the contents of information, to reduce its redundancy and to provide for a maximum of information over a minimal duration of communications.

The emergence of the second signal system constitutes a giant qualitative leap in packing information, since words

¹ Colin Cherry, *Op. cit.*, pp. 248, 63.

and speech represent a discrete coagulation, as it were, of a vast volume of feelings and perceptions. A large number of conceptions have been embodied into individual words, each of which is a point of concentration of information. With the help of a diversity of types of symbols, equations, formulae, and graphs man has thus learned to embody vast information contents into compact forms.

The existence of a specifically human signal, namely, the word, in which social information is embodied makes it possible for man to decode information and to immediately infer substantive contents from communications within the process of regulation. It is this which makes possible a wide and practically boundless range of reflection of reality and an absence of those types of physical constraints that are present in the case of nonsocial processes.

Social information emerges as the highest type of information for still another reason, namely that its utilization is associated with the highest type of goal-orientation, i.e., *conscious goal-orientation*, which is characteristic only of man as a social, thinking, goal-oriented, and consciously acting being.

Information is collected and processed in order to serve specific objectives. Whenever particular reports correspond to the achievement of particular objectives and contribute to them, they are selected and utilized. Reports concerning events whose probability is equal to either 1 or 0 do not contribute to regulation. In the first case, the information does not contain anything new. In the second it is useless, since it does not reflect the actual situation in any way.

Regulation processes are selective by their very nature. They are always associated with the processing of information and the selection of valuable information, i.e., of information that contributes to the solution of the problems that the system confronts. The greatest value attaches to information whose utilization permits a system to achieve the objective that it is pursuing. This explains the particular importance and complexities within regulation processes of the collection, filtering, and processing as well as utilization of information. The identification of goal-oriented constraints on the selection of sources of information, on the forms and methods of coding, acquiring, storing, processing,

decoding, and utilizing information is an object of continuing concern and attentiveness on the part of a subject of regulation.

Finally, there is still another attribute of social information that associates it with the highest form of information. This is the fact that social information contains *information concerning information*. This property of social information is associated with man's capacity to know himself, including his own cognitive and information capacities and their results, and also with the fact that he is able to organize and order information processes. Academician A. I. Berg and Yu. I. Chernyak have proposed to call this type of information meta-information. Meta-information is produced, for example, in developing automatic data processing systems, especially at the stage at which they are first brought into operation. One of the most valuable outcomes of such work is the accumulation of meta-information, namely, of knowledge, conceptions, instructions, and programs for the developing and processing of data and for the developing of decisions.

The organization of information and of information processes as well as methods used for amplifying them will be considered later.

TYPES OF SOCIAL INFORMATION

1. EXISTING CLASSIFICATIONS

As social information is classified, the very first question that arises concerns the principles on the basis of which this should be done. Naturally, as in the case of any other classification, information must be classified on the basis of those specific features, traits, and attributes that are inherent in different types of information.

Some specialists have proposed that social information be classified on the basis of the nature of its source, the means for identifying or transmitting it, and the nature of its users. In such a context the enormous wealth of corresponding information is divided into four basic streams, namely, measuring and regulating information, accounting and statistical information, scientific and technical information, and social and political information.

Other authors propose to divide social information into two basic types. The first refers to information *directly associated with regulation*, i.e., to information that circulates along channels of a given specific system and is employed in solving the problems that the given system confronts. The second refers to *information serving the development of systems*. This encompasses the outcome of research activities in science and technology that may be employed for fundamental qualitative transformations of individual systems. In a wide sense of that word, such information is intended to serve the informational requirements of scientific and technological progress.

Information directly serving regulation activities is expressed and identified in the form of specific sets of indica-

tors that make it possible to maintain systems in a given regulation regime. Such indicators are contained in documents that are organized in a particular way and are retrieved for users through factographic information retrieval systems.

Similarly, information related to the development of systems is contained in scientific documents (books, articles, reports, titles, dissertations). The search for required information in various documents is carried out through document-oriented information retrieval systems.

Naturally, such a classification, too, is justifiable, and yet, like any other, it is only approximate and conventional. In particular, scientific and technical information serves not only the development of systems but also their functioning, while information bearing directly on regulation processes and thus serving the functioning of the systems also contributes to the creation of required conditions for fundamental qualitative changes in systems. For the same reason that one cannot separate the functioning of systems from their development it is not possible to separate the types of information that serve each of these processes.

An imaginative attempt has also been made to classify social information in such a way as to serve calculations concerned with amortization, i.e., the association of its value with the objects that are produced with the help of information. That classification appears as follows.

The nature of the carrier of information determines whether it may be used repeatedly or only once. This serves as a basis for dividing information into *recorded and non-recorded* information. Recorded information may be employed repeatedly over a prolonged period of time. Nonrecorded information is employed only once, when it is received, and it is employed primarily for purposes of operational regulation.

Depending on the extent to which it is necessary to process information further before it may be employed, information may be divided into *primary, intermediate, and final information*. Primary information refers to initial unprocessed information. Intermediate information has been processed but not sufficiently to make possible its utilization in regulation processes. Final information has been fully

processed and brought to a state of readiness for utilization.

Both the objectives whose achievement is served by information and the sphere of its application provide a basis for dividing information into *universal, object-related, and functional information*. Universal information may be employed in relation to all objects of regulation. Object-related information may be employed for specific objects, while functional information may be employed for carrying out regulation functions.

The degree of *completeness* of information serves as the basis for dividing it into complete information that is full and ready for use in its present form, on the one hand, and incomplete information, which may be employed only together with additional information.

In terms of its content and of the *capacity and stability* of the communications that it contains, information may be divided into constant and variable information, into information concerning objective properties and concerning probable states.

In terms of *forms and methods of acquisition*, information may be divided into academic information, which is acquired in the course of learning from generally available sources and exchanges of experiences and working information, which is acquired in specific ways with the help of information-receiving means.

Thus information may be classified on the basis of a diversity of properties. Since there are many such properties it is natural to ask which should be preferred. In our opinion the selection of relevant properties is ultimately determined by *practice*, namely, by those scientific and practical objectives that a particular classification is intended to serve. In the words of Lenin, it is practice which serves as "a practical indicator of its connection with human wants".¹

The role of various classifications of social information is to serve the optimization of social regulation processes generally and of information processes in particular.

¹ V. I. Lenin, *Collected Works*, Vol. 32, p. 94.

2. INFORMATION CONCERNING THE FUTURE

Since social information is the outcome of a reflection of social reality as well as of natural reality (to the extent that it is involved into the orbit of human activity) information should above all be related to the *extent to which it corresponds to reality*, that is, to the real processes that occur within it.

All social information may then be divided into two large classes, namely, information *concerning the present*; that is, that which exists in reality (occasionally this information is called operational-technical information), and information *concerning the future*, which refers to forecasting and planning information.

Information that relates to reality and to the present is far more abundant than is information about the future. We will analyze that type of information in some detail later and will attempt to classify it. Initially, however, we will consider information referring to the future.

To regulate means not only to influence a system from the point of view of the manner in which it currently functions but also to identify trends in its development, forecast alternatives relating to its movement in the future, and with due account of these trends to design regulating operations in the present. The statement that to regulate means to *foresee* is therefore an appropriate one.

In socialist society an important aspect of information concerning the future is that it is comprehensively scientific, generalized, and systematic in character rather than empirical. The principles and findings of Marxism-Leninism play an important role in that information, for that is the only scientific theory about society which makes it possible to orient oneself in the present and also to anticipate the future as well as to explain the past.

Information which anticipates the state of the system in the future constitutes *forecasting* and *planning* information.

While the overall volume of forecasting information is still negligible, there is a clear trend both towards its increase and towards its wider and more comprehensive utilization. In the context of a socialist society forecasting information provides a basis for improving planning and the

regulation system by making that process more flexible and more future-oriented, as well as better able to perceive progressive trends in society's own development. Forecasting increases the extent to which regulation is scientific. It also makes it possible to determine correctly the long-term context of particular situations, to identify priorities, to take into account the most recent achievements of science and technology and the experience of leading organizations, and to increase a system's flexibility and capacity to respond rapidly and accurately to changing conditions.

The role of forecasting under socialism was emphasized at the 25th Congress of the CPSU. The Guidelines for the Development of the National Economy of the USSR for 1976-1980 which were adopted at that Congress refer to the need "to increase the degree of validity of forecasting scientific and technological progress and socio-economic processes, and to make broader use of these forecasts in elaborating national-economic plans".¹

The influence of forecasting information on regulation structures and regulation processes is very substantial. In particular it influences both the selection of objectives and the paths and means of achieving them. Accordingly, it also influences the selection of a structure for regulation organs, of methods of regulation, and of criteria for evaluating the functioning of regulating bodies.

More specifically, forecasting information performs the following functions:

Orientation. Information assists the subject of regulation in selecting objectives, the most promising and realistic directions in the development of society and of its individual spheres and links. It also identifies which problems should be given priority and in what sequence individual tasks should be carried out. Forecasting information makes it possible to create models of the future of a system over different time periods and to guide the system towards a realization of the model.

Normative Function. Forecasting information contains specific indicators and norms which, if followed, make it pos-

¹ *Documents and Resolutions. XXVth Congress of the CPSU, Moscow, 1976, p. 186.*

sible to realize the forecasting model. While it is true that these norms and indicators do not constitute directives, they help sketch out correctly those conditions that are needed for the model to be realized. They also contribute to a more accurate specification of those indicators which are of a planned and prescriptive nature.

Warning Function. Forecasting information makes it possible to anticipate a system's deviation from specified objectives and also possible causes for such deviations and as well as indirect consequences of particular decisions. This gives to the subject of regulation a capacity to enter corrective actions into the regulation process. Forecasting information increases a system's capacity to adapt to various changing conditions.

Accurate forecasts require many-sided information, and more specifically, information systems. Such systems possess a variety of elements. They include the system's current level of development and established stable trends, the current level of knowledge in science and technology and prospects for its further development; the availability of discoveries, patents, and licenses; available scientific and specialized personnel; the expected population growth and trends in the development of education; the state of the markets, of needs, and of fashions, etc. Only a system of interrelated indicators rather than the single indicator or group of indicators can provide a reliable basis for forecasts and assure their accuracy and feasibility.

The information aspects of forecasting have been considered to some detail by A. D. Ursul.¹

Forecasting refers to the acquisition of knowledge of the future state of a system on the basis of an analysis of its current state. In terms of its informational aspect forecasting represents sublated uncertainties through the logical processing of available information and an identification of data within it that represent signals, trends, prospects, and possible alternatives in the system's future movement.

Forecasts may be based on a statistical approach to information. In that case, the frequency distribution of the information under consideration is established as well as a

¹ A. D. Ursul, *Informatsiya (Information)*, pp. 263-73.

measure of uncertainty and other statistical characteristics. Yet a statistical or quantitative approach possesses limitations that make it inadequate for forecasting.

A. D. Ursul observes that more comprehensive models must recognize the fact that quantitative statistical characteristics provide only a partial measure of information and of its properties. Forecasting-information fulfills not only a communications function but also a regulation function, which is the most important one, and that means that information which is employed for forecasting must possess both content and value.¹ He proposes to generalize the stochastic character of forecasts to the level of forecasts that constrain variety and possess properties of anticipatory reflection. The process of forecasting may then be represented schematically as, at the very least, a threefold constraining of variety.

The first constraint concerns the identification of the object of forecasting within the overall volume of scientific information, as well as its structure and properties (its attributes, together with measure of their concentration and frequency). At this stage, existing trends in the development of certain characteristics are identified (such as quantity of information, redundancy, throughput capacity and rates of development) which follow from the given state of information, together with possible ways in which they may be changed in the future. Within such a limited volume of information a search of possible future structures is then carried out through purely syntactical methods and attempts are made to widen the initial variety and to produce a syntactical image of the future with multiple alternatives.

The second constraint refers to a reduction in the variety of possibilities (probability distribution). This is effected by using a criterion of significance of content, i.e., through a comparison of revealed trends of development and expected paths with the actual state of affairs. In such a context certain possibilities are rejected because they do not conform to natural laws or else to facts.

The third constraint concerns a selection, from a semantic image of the future, of the most valuable alternatives,

¹ A. D. Ursul, *Op. cit.*, p. 268.

so that by influencing the present it may be possible to realize the most optimal variant in the future.

At the present time, a discipline of scientific forecasting that relies on the methods of the social, natural, and technical sciences has in fact been established. The theoretical and methodological basis of a genuinely scientific forecasting is Marxism-Leninism, which by uncovering the regularities and tendencies of the past and present, makes it possible to foresee the future. Marxism-Leninism anticipates the social aspects of this future in general basic terms. As for the specific contents of individual spheres within that future, they are obtained through a concrete, sectoral, normative forecasting (the forecasting of progress in science and technology, of demographic processes, of the dynamics of labor force development, etc.). A number of methodologies are employed in such a context that rely on mathematical methods and on computer technology.

Scientific forecasting differs fundamentally from bourgeois futurology. As noted by A. Bönisch, a scientist from the German Democratic Republic, bourgeois futurology has been generated by the crisis of contemporary capitalist society and of bourgeois science. It "envisages an adaptation of capitalism to the condition of the scientific-technological revolution". Its objective is to bring about with the aid of "socio-technological methods" "a planned prevention of the crisis of capitalism" and to weaken the workers' movement.¹

The forecasting information of bourgeois futurologists does not possess a reliable objective foundation in the actual realities of capitalism. It is based instead on a fetishization of the role of science and technology in a capitalist society. It does not possess any scientific conceptions relating to the general direction of social development and of positive human ideals. The image of the future that it contains does not touch upon the essence of capitalism and does not carry beyond the framework of traditional conceptions of ideologists of "the affluent society", "the mass consumption society", "the industrial (postindustrial) society".

¹ A. Bönisch, *Futurologie. Eine kritische Analyse bürgerlicher Zukunftsforschung*, Berlin, 1971, pp. 29, 34-35, 236-237.

Such forecasting information contains a probabilistic image of the *relatively distant* future. In terms of its content, it is not a reflection of real processes that are taking place in the present. Instead, it characterizes a possible state of a given process in the future. The parameters of that possible future, moreover, particularly quantitative parameters, are not defined with sufficient accuracy, and are primarily of an hypothetical or orienting nature. The connection of forecasting information with the present is indirect and is mediated by specific mental operations (extrapolation of current trends in the future, or else a particular model of the future).

Planning information also relates to the future. But in a socialist country the outlines of that future are defined with some precision and are expressed in terms of concrete indicators which are largely quantitative. There the connection between planning information and the present is more reliable and direct since it follows from the current state of the system and takes into account its potential and its possibilities. Planning information is the outcome of precise calculations, while forecasting information is also based on the elements of guessing as well as on calculations.

Forecasting information serves as one of the foundations of planning information. It indicates to planning agencies the manner in which a system will develop in the future and the extent to which planned measures are feasible and realistic. It thus provides a context for planning which sheds light on it and accompanies it.

The essence of forecasts and of plans also differs from the point of view of epistemology. Developing forecasting information is essentially a learning process, namely, through the present acquisition of knowledge referring to a more or less distant future. The practical significance of a forecast is not as great as that of a plan. While the latter, too, is an outcome of knowledge, it is turned into an active instrument of operations. The regulating role of planning information is much more extensive and substantial than is that of forecasting information. Forecasts represent recommendations and are hypothetical, while plans are categorical and of a prescriptive nature. Plans contain norms and mandatory indicators. They acquire the force of laws that are ap-

proved by the state. Forecasts, on the other hand, do not contain obligatory indicators and do not always acquire the form of a state document. They may also relate to issues that lie outside the sphere of government operations. Forecasts serve as an information base for the preparation of possible alternative decisions by the state, while plans constitute an implementation of a particular alternative.

Forecasts provide guidelines to regulatory agencies concerning the possible development of a system and increase their sphere of freedom in taking decisions. In those cases when decisions are taken, they make it possible to foresee their indirect social consequences.

3. CLASSIFYING INFORMATION CONCERNING THE PRESENT

An essential basis for classifying information concerning the present is the nature of the *source* of information. Such a source may be both the object whose behavior is reflected in information and a subject producing and disseminating information.

A most general source of information in the sense of an object is society and the different processes that occur within it. This may be a socialist society as a whole or a territorial subsystem within its framework (a republic, a territory, a region, a district, etc.). It may be a sphere of social life (economic, socio-political, spiritual, and family and everyday life). It may also be a sector of a particular sphere (e.g., a sector of the economy). It may be a diversity of phenomena, facts, events, and processes of a social nature.

Different sources of information produce distinctions in types of information. This is true of *economic*, *political*, and *scientific and technical* as well as of other types of information. Economic information, for example, contains knowledge of the economic policy of the Party and state, as well as knowledge reflecting production relations and their manifestation in various spheres of the economy, i.e., concrete economic knowledge, knowledge of economic regulation

methods (financial accounting, prices, profits, material incentives, etc.), and knowledge of economic aspects of accounting and control.

V. I. Lenin attached an exceptional importance to economic information and invariably placed economic analysis at the basis of a socio-political analysis of social events, not to mention the Party's and government's economic policy. It was necessary, he wrote, to visualize "the different aspects and different manifestations of contemporary economic life as component parts of a definite system of social economy, as manifestations of the basic features of that system".¹

Within the system of social information, political and also scientific and technical information play an important role, and the concluding chapters of this work are devoted to that subject.

Each of these types of information (economic, political, etc.) is characterized by its contents and volume, by specific sources, and forms of movement and of processing and use in the context of regulation.

Clearly, there does not exist any "purely" economic or other type of information, just as there does not exist any "pure" economic, political, or spiritual activity. The economy, for example, serves as a basis for all other social relations with which it is intimately associated and with which it interacts. It is therefore natural that economic information, too, is closely associated with other types of social information.

Essentially there do not exist any phenomena in society that do not rest on infrastructures containing persons, on their position within social collectives, their level of welfare, and of culture, etc. It follows that economic information proper necessarily contains socio-political aspects. If, for example, we note the fact that the real incomes of workers and office personnel in the Soviet Union have increased by three times between 1940 and 1971, while the real income of collective farmers has increased by 4.8 times, these figures convey a tangible impression of the change in the position of these classes and social groups in society as

¹ V. I. Lenin, *Collected Works*, Vol. 4, p. 48.

well as of their professional training and general level of culture. These figures serve as landmarks in the realization of the principal social objective of a communist society, namely, the achieving of social equality and abundance as well as of a situation in which each person receives the possibility to satisfy his needs fully and to develop his abilities and talents.

In those cases in which the source of information is the *subject of regulation*, it is necessary to distinguish *party* and *state* and other information.

Information is also distinguished on the basis of the particular *regulation functions* that it serves. The primary function of regulation concerns the formulation and taking of decisions. Information that is employed in carrying out that function will be called *primary* information. Indeed, in order to take a particular decision (plan, directive, law, etc.) it is first necessary to obtain reliable information of the state of the problem that it is proposed to resolve, the possibility of solving it, the availability of corresponding resources, the readiness of persons to participate in solving it, etc. Only on the basis of a comprehensive study of primary data is it possible to take a well-grounded and hence, a feasible, decision.

In carrying out the organizational functions of regulation, *organizational* information is needed, which would reflect the process of creating a state of ordering for both the subject and the object of regulation as well as the development of both direct and feedback relations among them. Organizational information assists the subject of regulation in ordering the regulation cycle, determining the sequence and direction of regulatory operations, selecting and consolidating the structure of subjects and objects of regulation and rationalizing relations among them and in allocating regulatory functions as well as rights and responsibilities among units and personnel of the regulatory system. Organizational information makes it possible to "translate" regulating decisions into the language of practical activities and to embody them into real operations. An organizing of information takes place in carrying out organizing functions, that encompasses its selection, an interaction among its different streams and types, and its systematization, i.e., a determina-

tion and specification of forms of information, its contents and volume, and frequency of its acquisition.

Much importance attaches to the role of *regulating* information. Above all this refers to instructions, norms, rules, standards, and specifications that are contained in the regulating decision. These are "commands" that are conveyed to the object of regulation and whose execution itself is regulated. This constitutes prescriptive information. Prescriptive information, however, presupposes descriptive information i.e., reports about the state of the subsystem being regulated, and its deviations from a specified program. It is only on the basis of an analysis and processing of descriptive information that it is possible to develop prescriptive information. Since both prescriptive and descriptive information serve the execution of the regulation function, they may both be viewed as regulating information, provided, of course, that one does not neglect their relative autonomy and the distinctions between them.

And finally, there is information employed in carrying out the functions of accounting and control. *Accounting* information represents reports that are usually expressed in a quantitative form and in terms of quantitative indicators relating to available resources and to the consequences of carrying out decisions. Naturally, accounting information also contains specific data relating to quality such as the nomenclature of products, their assortment, and their correspondence to standards. Nevertheless, it is to the collection and analysis of quantitative information that accounting primarily refers.

Accounting information may itself be divided into subtypes that include statistical information, book-keeping information, and technical and operational information. An important characteristic of statistical information that makes it particularly useful in the regulation of society derives from the fact that it operates with large numbers. For in the case of society, the subject of regulation is always concerned with mass stochastic phenomena, with mass behavior, and activities of large numbers of individuals, with masses of items, and masses of the most varied phenomena and processes. Book-keeping information refers to data concerning the circular flow and movement of financial resources as

well as of material and human resources expressed in terms of money. As for operational and technical information it serves direct needs of operational regulation. It informs the subject of regulation on a daily basis about the state of resources, bottlenecks, daily movements of equipment, materials and personnel, and the course of technological processes.

Control information is closely associated with accounting information. More specifically, accounting information possesses a control function as well, since it embodies the results of carrying out decisions that are expressed in terms of numerical indicators. Control information reflects the correspondence of processes and outcomes of the functioning of a system to the requirements of prescriptive information contained in decisions—in laws, plans, norms, rules, etc. Divergences between indicators contained in control information and prescriptive indicators serve as signals indicating the need for regulatory activities and for correcting current decisions or else taking new ones.

Since the division of the process and cycle of regulation into the functions of taking and developing the regulating decisions, organizing, regulating, and performing accounting and control activities is itself relative and conventional, so is the proposed classification of types of information in accordance with these functions. For in fact not only are all types of information intimately linked to each other, but they also "interpenetrate" each other, merge with each other, and are transformed into each other. In particular, accounting and control information becomes primary information for the taking of new regulatory decisions. It is only when they are taken in their unity and in their dialectical interaction that different types and subtypes of information provide a conception of the system of information that is employed in regulatory activities.

Depending on its *direction* (the direction of its movement) information is divided into *horizontal*, flows of which circulate among regulatory bodies at a given level (e.g., from ministry to ministry, or from enterprise to enterprise) and *vertical*, information which circulates among regulatory organs located at different levels (e.g., from ministry to association of enterprises, to enterprise and back).

Information that circulates along vertical channels may in turn be divided into direct information (from the subject of regulation to object of regulation) and feedback information (from object of regulation to subject of regulation). Direct information is largely *directive and normative*, while feedback information is largely *accounting and control* information.

Similarly, a distinction is made between *internal* information (relating to a given system) and *external* information (relating to the system's environment). The basis for distinguishing between them is provided by the boundaries within which information circulates.

There exists a dialectical interdependence between internal and external information. A strong prevalence of internal information results in the self-isolation of systems, as a result of which they lose their role as elements of more comprehensive systems. Ultimately, this may result in the disorganization of systems and even in their disintegration. Whenever a strong prevalence of external information exists the system will not be able to assimilate it, digest it or neutralize it, and this, too, produces a harmful effect.

Spheres of application of information provide still another basis for its classification. *Universal, non-goal-oriented* information does not possess a rigorously bounded sphere of application or circle of users. The number of units receiving it is relatively large and flexible. Thus, *demographic* information is employed by regulatory bodies concerned with the economy, with health, and with daily services and trade, among others.

Specially addressed information is intended for the use by specific users for solving equally specific tasks. This is true, for example, of information relating to individual branches of science and technology which is usually employed by a narrow circle of specialists.

Operational and technical information is also specific in character. It is forwarded from the source directly to the user, since it meets specific needs of direct everyday regulation. Delays cannot be tolerated in such cases for the reason that they may interfere with the continuity of regulation. This type of information is poorly suited for the

integration and processing needs of centralized systems. Usually it is subjected to only the most elementary processing.

Information may also be distinguished in terms of the *degree to which it is organized*. In particular, it may be divided into *systematized* information, which is subjected to rigorous regimentation over time (in relation to periodicity and times at which it is received) as well as in terms of the composition of its indicators, the scope of units sending and receiving it, and of forms of presentation (through documents, by telephone, through verbal reports, etc.). *Nonsystematized* information is information that has not been ordered or else has only been partly ordered.

Information is embodied into various material forms and is also perceived by persons in different ways. In addition it circulates along a variety of channels and is expressed in terms of specific structural, symbolic elements and positions. This produces such types of information as *visual* (visible, documentary) and *audio* information (audible), *written and oral, radio information and tele-information, newspaper information and other published information, information embodied in artistic works, etc.*

Symbols are elements of measurement and isomorphic expression of the characteristics (quantitative and qualitative) of the system that is reflected in information. The coordinates defining the distribution space of symbols are called its positions. The overall set of symbols of a given type constitutes an *alphabet* of information. Depending on the *character of the alphabet*, information is divided into *continuous* and *discrete*. In the case of continuous information, the overall set of symbols constitutes an uncountable set, while in the case of discrete information, that set is countable, such as an alphabet of letters in a particular language, which will contain a finite number of letters.

Continuous and discrete information is itself divided into a number of subtypes, depending on the type of alphabetic symbols that are employed in expressing it and their position. This refers to literal, numeric, binary, decimal, sound, speech, and other types of information.

Regulatory activities employ *code* information, that is, information whose structure is determined by purposeful operations on the part of the regulating subsystem (the agency or subject of regulation). Code information differs from *natural* information whose structure is determined by those objective processes that are occurring in nature and society and which it reflects.

Different types of information may transform themselves into each other, i.e., may be encoded. Encoding, i.e., the juxtaposition of symbols and positions of different types of information, is carried out in accordance with specific rules of coding or codes.

It is important to note the presence of isomorphism between code information and natural information. In other words, a system of symbols and positions makes it possible to express objective processes and changes taking place in nature and society. This most important property of code information makes it the basis of regulatory processes and of operations on objects in accordance with specified objectives.

Naturally the classification of types of information that has been proposed is quite relative and a specific item of information may manifest itself in various types. Accordingly, the regulation of social objects usually requires complex information.

CHAPTER IV

SOURCES OF SOCIAL INFORMATION

Science constitutes one of the principal sources of social information that is also boundless by its very nature. This refers, moreover, to science as a whole, that is to social, natural, and technical sciences taken together. Natural and technical sciences play a threefold role. First, they are themselves a direct source of scientific and technological information. Secondly, they serve as a basis for the development and production of technical means for processing information, which is the basis of the information industry. Third, the methods of these sciences, and especially cybernetics and mathematics, are increasingly penetrating the social sciences within which Marxism-Leninism is a principal "supplier" of social information.

1. SOCIAL INFORMATION AND THE SOCIAL SCIENCES

The practical operations associated with social regulation require knowledge concerning various levels of social relations and therefore social information that varies in terms of its level of generality.

Above all this refers to information at the *overall sociological level*, that is, to knowledge of the most general laws that govern the formation, functioning, development, and replacement of socio-economic formations.

It includes information about a given society's social structure at a given stage of its development (relations

among classes, large social groups, nations, cities and villages, persons engaged in intellectual labor, persons engaged in physical labor, etc.).

It includes information of different social systems and different aspects of social structure that produces concrete relations among the basic classes and within large social communities and social groups.

It also includes information concerning small groups and primary working collectives.

Social information that is employed in regulation, thus constitutes an integral unity of theoretical generalizations and empirical materials. The proportion of empirical to theoretical elements in such information differs at different levels of social regulation. The higher the level, the more it is theoretical. The most generalized and theoretical information is the one that is employed by the central bodies of the Party and the state. This represents primary and basic information for the development of policies and major decisions relating to a socialist society as a whole, or else to leading spheres in its life and development.

Scientific regulation constitutes a conscious activity of persons, and of social institutions that is based on a knowledge and utilization of the objective laws that govern the functioning and development of society.

Knowledge and information about these laws is provided by Marxism-Leninism and Marxist sociology, which constitutes the *general theoretical* and *methodological basis* of scientific regulation.

Yet social laws do not operate in a linear manner and in terms of unique correspondences. They determine but do not predetermine the direction of flow of social processes. Their traits and requirements may be modified, moreover, by specific, concrete situations, and for that reason, they represent different possibilities and different variants of social movement. Accordingly they offer a certain freedom of choice to the subject of regulation. To identify such modifications of operating laws in concrete situations and different possibilities and alternatives, and to study alternatives and then select the most rational one among them is again a prerogative of the social sciences. The comprehensiveness and quality of the information that they provide

de in relation to these questions is an important, not to say the most important, condition for assuring the scientific reliability and effectiveness of social decisions. It is not accidental that both the recent congresses of the CPSU and the day-to-day activities of the CPSU's Central Committee have attached great importance to the social sciences. This refers to the circumstance that the social sciences should not limit themselves to comments concerning decisions that have already been taken, but should rather study social events in all their complexity and contradictory nature from a goal-oriented point of view in order to provide recommendations in forms that may then be employed in the practical activities of regulation.

It is only by relying on comprehensive and accurate information about the processes of communist construction, that it is possible to guide the development of Soviet society from socialism to communism in a scientific manner.

Within the sphere of social regulation the social sciences are used not only for the taking particularly important decisions by society's leading bodies, but also in contributing to the education and general enlightenment of the working population, and increasing the level of their competence in discussing and solving problems that arise in the development of a socialist society. They equip working people with a scientific view of the world and help them orient themselves in the complex labyrinths of social events.

It is the task of the social sciences to provide regulation bodies with information on the essence of particular social laws, the forms in which they may manifest themselves, their mechanisms of operation, and their implications in the context of specific situations. The social sciences analyze the experience of the past and the present state of society, and provide forecasts for the future.

As the role of Marxism-Leninism and of the social sciences grows in providing a methodological and general theoretical basis for regulation generally and for the processing of information in particular, these sciences acquire a growing importance as *applied* ones as they provide information and designs for resolving problems of regulation in different spheres of social life.

It should be emphasized that the volume and "assortment" of information that is supplied by the social sciences and employed in social regulation is continually increasing. This is associated with the widening scope of studies of social phenomena and large-scale applications of concrete sociological studies, with an increasing closeness of theoretical studies to empirical ones, and with the further development and improvement of methods for understanding social phenomena. This refers above all to the application of mathematical, statistical, and cybernetic methods and to an increasing reliance on experiments and on modern technical services.

The social sciences provide information that is employed in social modeling, in planning, and in forecasting. It is not possible to imagine a scientific regulation of society without these elements.

An important task of the social sciences is the development of "social technology", that is of ways to utilize social information in practical managerial activities.

The problems of regulation are complex system-oriented problems and require a systems approach. Their solution calls for a similar systems approach to social information and to its acquisition as well as processing and utilization. That approach is one of the most important methodological requirements of Marxist-Leninist dialectics, and one of the forms of applying to concrete situations the dialectic and materialist teachings concerning general interdependence and general movement, and the development of material reality and the forms in which it is reflected in the consciousness of men.

Both in modern science generally and in sociology the terms "systems", "structure", and "systems approach", are used very widely. In the West, it is asserted with increased emphasis that a systems approach constitutes a new methodology and a new view of the world which alone corresponds to the spirit of our time, and the requirements of modern science and of technology. Already in 1950, a book entitled *The Whole in Philosophy and in Science*, was published in Vienna, in which it was asserted explicitly that the principle of a systems approach and of wholeness constitutes the specific philosophy and methodological basis

of science and provides that "magic key which is capable of unlocking the full wealth of reality".¹

Similar views have been widespread in recent years. There has been an intense development and emphasis on "structuralism", "functionalism", and other trends in bourgeois philosophy and sociology that are based on different types of idealistic and ant dialectical speculations concerning the "systems approach" and "systems methodology".² These speculations constitute different manifestations of a type of "systems-oriented" positivism as well as of an abandonment of attempts to solve specifically philosophical problems through their replacement by partial approaches and an attribution of universal methodological significance to certain principles that are common to science or, more specifically, to relations among individual sciences. Above all this refers to the principles of mathematics and of logic, which do not possess any autonomous or general philosophical significance bearing on the development of a world view. Such trends are also characteristic of the systems approach. In the West, they generally possess a clearly pronounced class-orientation in the sense that they seek to provide a basis for stability and "homeostasis", but more simply, for the eternal and permanent character of the capitalist social system, and to search for ways of overcoming or at least reducing the deep contradictions that are inherent in it. An example of this is provided by Talcott Parsons' structural functionalism.

Under these circumstances, it is important to emphasize that the general methodological foundations of the systems approach, i.e., the study of complex objects as systems do not, in fact, represent a novel contribution by contemporary representatives of the systems approach, and especially not by authors who interpret these developments in an idealistic or positivistic manner. The systems approach had already been provided with a philosophical basis a century ago by K. Marx. Not only was it provided with a basis, moreover,

¹ *Die Ganzheit in Philosophie und Wissenschaft*, Wien, 1950, S. 32.

² We are not referring to "systems analysis", which is widely applied in the managerial theory and practice of capitalist production and whose significance is primarily of an applied nature.

it was brilliantly applied to the analysis of capitalist production and of capitalist society.

The systems approach to society found its expression in the teachings of K. Marx and F. Engels about socio-economic formations, which represent the most general and universal form of social integration and of systems structure and the basic form of existence of social matter. It represents a combination of social phenomena (economic, socio-political, spiritual, family, and everyday-life) as well as other social phenomena that are intimately associated with each other and that rest on historically determined mode of production of material goods. Socio-economic formations are dynamic, developing systems, whose sources of development, moreover, are internal rather than being somehow introduced from the outside.

Having created a body of knowledge concerning the nature of socio-economic formations as systems that identified the organic unity, and mutual interdependence of various social phenomena, K. Marx and F. Engels refuted the corresponding idealistic and metaphysical views of pre-Marxist sociologists on society. They have shown the inconsistency of non-historical, abstract views concerning social life and have shown that there do not exist societies in general, but only historically specific societies. This refers in Marx's words, to a society "*at a definite stage of historical development*, a society with a peculiar, distinctive character".¹

Subsequently, Lenin further developed and also defended the systems-oriented view of society. He wrote that society is "something definite, integral, pervaded by some principle..."² That principle refers to the activities of people in the area of material production and to the relationship among persons that such activities create. In criticizing concepts that view society as "a simple mechanical aggregation of various institutions, a simple mechanical concatenation of various phenomena", Lenin called for studies of societies in which they are viewed as a social organism, as

¹ Karl Marx and Frederick Engels, *Selected Works* in three volumes, Vol. 1, p. 160.

² V. I. Lenin, *Collected Works*, Vol. 1, p. 139.

"a definite system of production relations, as a definite social formation".¹

Socio-economic formations constitute the most general form of social systems structures, and one in which inherent is the regulation process itself.

Truth does not exist abstractly, it is always specific. Such is one of the fundamental requirements of Marxist dialectics. In the context of regulation, this means that there do not exist any abstract non-historical systems, processes and methods of regulation. Just as a particular socio-economic formation constitutes a concrete historical form of existence of society, then regulation, too, inevitably acquires a concrete historical character, which in a class society is also *class-oriented and political*. A systems approach to class societies, to their regulation and to social information in such societies above all implies a class approach and a political approach.

It should be noted that the systems approach is itself systems-oriented. It includes a number of interrelated aspects, none of which may be ignored in the acquisition of knowledge and in the development and analysis of social information.

This refers to the following aspects:

the systems element aspect, which identifies the components from which the system is constituted;

the systems structure aspect, which describes the system's internal organization and the ways in which its components interact;

the systems functioning aspect, which indicates the nature of the functions that the system itself performs as well as the functions of its components;

the systems integrating aspect, which identifies the sources, and factors that operate to preserve, improve, and develop the system (in the context of social systems this refers to regulation factors);

the systems process aspect (procedural, operational), which identifies the processes (operations, procedures) that are being carried out within the system in order to maintain its integrity and to improve it and develop it;

¹ V. I. Lenin, *Collected Works*, Vol. 1, pp. 188-89.

the systems communications aspect, which identifies the linkages of a given system with others, both horizontally and vertically;

and the systems historical aspect, which describes the manner in which the system first appeared, the stages of its development, and its historical prospects.

Naturally, specific studies of social information and of regulation activities may utilize information that identifies the contents of only one such aspect or else of some combination of those aspects. The development of comprehensive information, however, and an effective practical regulation of an overall system, require a comprehensive utilization of information bearing on each of these aspects of the systems approach.

In studying social processes a systems approach makes it possible to combine analysis and synthesis in an organic way, as well as quantitative and qualitative methods. This opens wide possibilities for applying heuristic and logical and mathematical methods as well as computers to studies of social information.

The importance of a systems approach to understanding and regulating society is especially great in developed socialist societies, which finds it both necessary and possible to solve highly complex problems that call for an interaction of different spheres, aspects, and sectors of the economy and of social life.

At the 25th Congress of the CPSU, L. I. Brezhnev noted that "the time has come to settle the question of improving the methods of comprehensively resolving interbranch and territorial problems that are of major importance to the state. In this area there must be unified, centralized programmes covering all phases of work—from designing to practical execution".¹

The need for planning and regulating socialist societies through the methods of goal-oriented program planning can no longer be neglected. Its essence lies in solving concrete, individual, sectoral problems in a context that subordinates them to the achievement of the general objectives

¹ *Documents and Resolutions, XXVth Congress of the CPSU, Moscow, 1976, p. 72.*

that are placed before society at a particular stage of its historical development.

One of these objectives which has been formulated by the 25th Congress of the CPSU is the problem of combining in an organic manner the achievements of the revolution in science and technology with the advantage of a socialist economic system. Achieving that objective calls for the solution of an entire complex of interrelated problems, including a further intensification of scientific creativity in order that a stream of original scientific and technical ideas may continue to feed into production and social life; a further improvement of the organization of production in order that it be able to assimilate the newest ideas in science and technology, and in order, too, that it may identify for science new problems required by society's development; a rational organization of linkages between science and production in order to provide for the best and most rapid incorporation into production of scientific and technical ideas; and the further improvement and development of a system of education and of upgrading the skills of professionals, workers, and collective farmers so that they may be able to work creatively and also carry out in practice the achievements of the revolution in science and technology.

When it is understood from the point of view of Marxist dialectics the systems approach is a powerful instrument for understanding and regulating socialist society.

In regulating a society, it is extremely important that the theoretical construction of Marxism-Leninism and theoretical information be transformed into specific applied conclusions and proposals in an objective and operational manner. Like the other sciences, the social sciences possess differing levels of abstraction. The highest levels of abstraction are achieved by Marxist-Leninist philosophy, by political economy, and scientific communism. These "upper floors" of knowledge about society include a group of sciences which serve both as a source of information and as a channel for applying ideas of a general, theoretical nature to specific situations.

Above all, this refers to empirical sociology and statistics. These sciences translate general conceptions into the

language of concrete data, and identify concrete manifestations of the regularities that they find in observed reality.

Empirical sociology. Both society as a whole and any partial social system may be regulated only when all the components entering into the system and all parameters relating to their mutual linkages and interdependences become known. It is the task of empirical sociology to study the social relations that are formed within social systems characterized by differing levels of organization, ranging from societies, classes and nations to small collectives, and making use of the achievements of a diversity of other sciences to identify the dynamics of these relations on the basis of the methodology of Marxism-Leninism.

In *Capital*, Marx has shown convincingly that in order to gain an understanding of social events it is not possible to limit oneself to studies of general characteristics alone, nor to general laws of development or basic conditions governing the functioning and development of systems. It is so that "this does not prevent the same economic basis—the same from the standpoint of its main conditions—due to innumerable different empirical circumstances, natural environment, racial relations, external historical influences, etc., from showing infinite variations and gradations in appearance, which can be ascertained only by analysis of the empirically given circumstances".¹

It is sociological research that makes it possible to study the variety of "empirical circumstances" through which general laws of development manifest themselves. It also helps in gaining an understanding of the very complex interweaving of social relations within which the general trends of movement of a given society are expressed in each specific country, and within it, in each social cell.

The importance of sociological studies for regulation derives from the fact that they help identify the anatomy and physiology of a social system, the structural and functional linkages that characterize it, and the trends in its development. In reflecting social processes in all their diversity and complexity, their contradictory nature and concrete manifestations, they provide reliable information to regulat-

¹ Karl Marx, *Capital*, Vol. II, p. 792.

ing bodies that makes it possible to evaluate the effectiveness of a particular regulation system and to generalize and disseminate the experience of leading bodies. They help in identifying ways for further improving the regulation process on the basis of new facts, phenomena, and emerging trends. These studies provide data for generalizations and for identifying new laws of development, which may then be utilized for a further improvement of regulation.

Aside from helping in the preparation and taking of regulation decisions sociological studies also help in understanding the mechanisms through which they influence persons, and the responses of different categories of the population. They also make it possible to follow how these decisions are transformed into the thinking and behavior of persons and influence the course of social events, as well as relations among collectives, social groups, and individuals. This will require, however, a further development of socio-psychological studies whose objective, in the context of regulation problems, is to study the perception and implementation of regulatory decisions.

Naturally, information derived from empirical social studies may be employed effectively in regulation only if it is reliable. The corresponding criteria include: its representativity (this includes the problem of reliability over time), an adequate correspondence of collected data to the actual state of affairs (for example, the correspondence of the state of opinions to the true judgement of respondents), the quality of the processing of primary data, and the logical consistency of conclusions.

Users of information are not able to verify the reliability of the outcomes of studies in terms of all these parameters. This places a particular responsibility on researchers for the quality of their work.

The central problem of empirical social studies concerns their *representativeness*. It is well known that in empirical studies it is usually neither necessary nor possible to collect information about all elements of a particular set. Instead a sampling method is employed in which information is collected concerning only a relatively small part of the set of phenomena under study. It is then necessary,

however, that the "sample set" be representative of the "general set" (population). This refers, moreover, not merely to the correspondence of particular quantitative characteristics of the sample and larger sets, but also to their social character and social essence.

An absence of representativeness makes it impossible to apply the outcome of studies beyond the concrete object for which studies have been carried out. It is then not possible, in short, to apply such findings to other objects that are similar or close in nature. It is precisely representativeness that makes it possible to extrapolate the results of a study to a wide range of objects and to identify general trends and laws of development governing specific processes.

In such a context the method that is employed most widely is the method of questionnaires. Yet, this does not make it possible to arrive at ideal results. An ideal study would be one in which the opinions of individuals would be recorded in tables that possess a fixed interpretation. The reasons why in fact this is not possible, include the methodological shortcomings that attach to the collection of information; an inadequate editing of responses (the so-called "quantification noise"); the psychological influence of the specific circumstances under which the question is presented to respondents; a shifting of samples; errors in interpretation (this refers to the process of translating coded numerical information into statements, opinions, and recommendations); shortcomings in the operation of equipment, including key punches and computers; and errors of personnel responsible for coding operations, which are inevitable when manual coding is employed, and which are associated with the pressure of time, with imperfections of coding equipment, and with the monotonous character of operations.

One important task, accordingly, is to overcome these difficulties and seek to achieve a greater measure of reliability of information.

The scope and number of sociological studies has grown considerably in the Soviet Union in recent years. This has been stimulated, in part, by the publication of studies concerned with general problems of empirical sociological

studies¹ and containing sociological analyses of several specific aspects of social life including the following: production relations and their specific manifestations in different social collectives; the social consequences of the scientific and technological revolution; the class structure of society, the nature of interclass and intraclass relations and characteristics and the dynamics of social groups and of relations between individuals, collectives, and societies and within collectives; the problems of work and leisure and of the working time and leisure time of working people; the participation of the population in the management of social affairs; and the social problems of urban centers and of rural settlements.²

¹ The numerous books and articles, that have been published on problems of economy and reliability of sociological studies, include the following: *Problems of the Sociology of the Press*, Issue 1, pp. 240-41; *Experience in Methodology of Empirical Sociological Studies*, Moscow, 1965; *Sociology in the USSR*, Vols. I, II, Moscow, 1966; A. G. Zdravomyslov, *Methodology and a Procedure of Sociological Studies*, Moscow, 1969; V. A. Yadov, *Sociological Studies: Methodology, Program, Methods*, Moscow, 1972; V. E. Shlyapentokh, *Problems of Reliability of Statistical Information in Sociological Studies*, Moscow, 1973; M. N. Perfilov, L. V. Orlova, *Social Relations*, Leningrad, 1973; A. K. Uledov, *Sotsiologicheskiye zakony* (Sociological Laws), Moscow 1975; *Rabochaya kniga sotsiologa* (Sociologist's Handbook), Moscow, 1976; *Sotsiologiya i sovremennost* (Sociology and the Present), Vols. 1, 2, Moscow, 1977.

² Cf. *Sociological Studies of Processes of Change in Social Structure of Soviet Society*, Bibliographic Index of Literature for 1966-1972; L. A. Gordon, E. V. Klopov, *Man After Work: Social Problems of Daily Life and Leisure Time*, Moscow, 1975; V. G. Podmarkov, *Introduction to Industrial Sociology*, Moscow, 1973; *Social Factors That Increase the Effectiveness of Labor in Industrial and Transportation Enterprises*, Issue I-III, Moscow, 1973; *Problems Relating to the Effective Utilization of Personnel in Industrial Enterprises*, Moscow, 1973; P. I. Simush, *Sotsialnyi portret sovetskogo krestyanstva* (The Sociological Outline of Soviet Peasantry), Moscow, 1976; *Problemy razvitiya sotsialnoi struktury obshchestva v Sovetskoy Soyuz i Polshe* (Development of the Social Structure in the Soviet Union and Poland), Moscow, 1976; *Sotsialny oblik kolhoznoi molodezhy* (The Social Characteristics of Collective Farm Youth), Moscow, 1976; *Sotsialnoye upravleniye proizvodstvennym kolektivom. Opyt sotsiologicheskogo issledovaniya problemy* (Social Regulation of the Production Collective. A Sociological Study), Moscow, 1976; *Sotsialnaya struktura razvitogo sotsialisticheskogo ob-*

For several years, complex sociological studies of regulation problems have been carried out by the Institute of State and Law of the Academy of Sciences of the USSR. In particular the actual experience of government institutions is being studied in the context of the economic reform that is currently being implemented. Other subjects include the structure and functions of regulatory institutions; the movement of information flows; the documentary basis of regulation; the effectiveness of regulatory decisions; and the organization and labor activities of managerial personnel.¹ The Institute is also engaged in studies of the relation of regulation activities to forecasting, in a structural-functional analysis of government decisions, in a study of socio-psychological factors in regulation, and of sociological procedures for studying problems of regulation, including the possibility of relying on mathematical and statistical analysis.

The use of sociological methods to study public opinion concerning a variety of decisions, measures, facts, and events as well as of the opinion of responsible officials at various levels has been quite effective. Studies of social opinion make it possible to identify socio-psychological situations in society and within its individual subunits, as well as the degree of readiness of working people to solve specific problems. It also makes it possible to identify shortcomings, difficulties and contradictions in labor activities and in everyday life so that they may be overcome successfully and in time.

Insufficient attention has been given to subjects that are directly concerned with problems of regulation in Soviet society. Yet, in order to improve a regulation system, it is necessary to know how effective it is, the extent to which it contributes to technical progress and to the growth of

schestva v SSSR (Social Structure of the Developed Socialist Society in the USSR), Moscow, 1977; *Problemy sotsialisticheskogo obraza zhizni* (Problems of the Socialist Way of Life), Moscow, 1977.

¹ Cf., *Upravleniye, sotsiologiya i pravo* (Regulation, Sociology, and Law), Moscow, 1974; *Pravo i sotsiologiya* (Law and Sociology), Moscow, 1973; V. A. Safarov, *Obshchestvennoye mneniye i gosudarstvennoye upravleniye* (Public Opinion and the State Regulation), Moscow, 1975.

labor productivity, the extent to which regulatory decisions are taken in a competent and operational manner, and to which regulation activities are consistent, the manner in which they are adjusted in response to changes in the internal and external environment of the objects being regulated, and the extent to which effective forms of accounting and control have been instituted.

Statistics. Regulation of society presupposes the availability of information resulting from a careful study and generalization of large volumes of facts as well as of a system and of a set of facts that represent the particular social process under consideration. In solving that complex problem empirical sociology is greatly assisted by statistics.

Statistics represent a method for studying mass stochastic phenomena. Mass phenomena constitute an attribute of any society including socialist societies. While each of these phenomena contains an element of probability, they also reflect an objective necessity that unfolds behind them. This represents a trend that asserts itself through large numbers of such phenomena that intersect and interact with each other.

It is true that in the case of social phenomena that take place within a socialist society, the individual elements of the larger population will not always be a probabilism. For example, the trend to increasing incomes in particular districts may be studied in terms of the growth of income of individual families. Since individual incomes are determined not only by general conditions but also by specific ones, random deviations are possible. Yet in socialist society the growth in incomes is itself not accidental. Accordingly, statistics in socialist societies are concerned with individual phenomena possessing random deviations rather than with random phenomena. And statistical methods do provide a means of gaining knowledge that makes it possible to systematize phenomena possessing random deviations and discover specific regularities that underlie them, that constitute indicators of causal relations, laws of behavior, and trends. The particular correspondence between generalizing statistical indicators and the distribution of statistical data constitutes a specific expression of the es-

sence and the laws on the basis of which it is possible to regulate and to consciously influence objects. Generalizing statistical indicators represent an expression of laws of behavior that result from a mutual attenuation of a large number of individual phenomena possessing deviations of a random character. Under certain very general conditions, the net result of combined influences on the part of a large number of individual causes and circumstances (containing a random element as well) is almost independent of specific cases. This constitutes the essence of the law of large numbers on which statistics is based.

Activities associated with economic planning naturally impose a constraint to the law of large numbers. In principle, deviations of individual cases from a general norm should not be too large under socialism, although such deviations will always exist and will therefore cause the law of large numbers to operate in socialist societies as well.

The grouping of phenomena being studied occupies a central position in statistics and serves as a basis for a scientific processing of statistical data. Such grouping makes it possible to combine individual units of a statistical population into specific categories and types possessing a common essence and expressing a social homogeneity. In such a context, moreover, it is very important to select correctly the attribute on which such groupings are to be based. In the absence of a scientific approach to grouping and of a proper differentiation among groupings according to social attributes statistical data will not express the essence of phenomena and cannot serve the tasks of regulation. They will provide, instead, a biased image of social reality.

The statistical methods that make it possible to identify such trends and laws within a mass of concrete phenomena rest on generalizations of observed data, their grouping, calculations of auxiliary analytical data, studies based on partial samples, and differentiated indicators relating to territorial units.

In socialist societies it is the task of government statistics to organize the monitoring and analysis of processes taking place in social life, and to measure the extent to which the activities of regulating bodies correspond to the

requirements of laws of development. In particular, it is the task of statistical studies to determine the quality of regulation activities, and especially of plans, in order to identify those factors that contribute to the carrying out of plans as well as the causes of failures.

While the USSR's government statistical services have had important achievements in the study of mass phenomena and in summarizing the outcome of the activities of society as a whole and of individual spheres and sectors of social life, its role as one of the most important channels of information needed for regulation activities is still inadequate. In particular, it is still insufficiently concerned with problems relating to the identification of correspondences between regulation activities and objective possibilities and with qualitative analyses of the effectiveness of regulation activities. In analyzing the work of enterprises, for example, statisticians are usually content to group enterprises in terms of attributes relating to the fulfilling of plans or failures to fulfil them. As a result it is not clear whether it is because of the plan's own shortcomings and its failure to correspond to objective possibilities that it has not been fulfilled in terms of specific indicators, or is it because of shortcomings in the sphere of administration?

Since social processes develop as a result of a large number of interacting factors, it is the task of statistics to show the place and role of each of these factors within the overall process and to identify causal relations as well as bottlenecks.

In socialist society statistical services go beyond a mere recording of results. They carry out a comprehensive analysis of laws of development and objective factors and forecast particular events, including unfavorable ones, in order to help regulating bodies prepare measures that may forestall undesirable phenomena. In particular, Lenin demanded that statisticians not merely record facts or collect various data in non-systematic ways, but carry out deeply scientific analyses and comparisons leading to practical conclusions and proposals. He wrote that statisticians should be our practical assistants rather than researchers in the scholastic tradition.

Surprising though this may be, an emphasis on the recording of facts causes statisticians to ignore the specifically "statistical" nature of manifestations of the laws governing societies. These appear as certain trends and as an average statistical outcome of the interaction of a large number of social facts. Such a statement does not imply that Soviet statistics do not possess a sufficient quantity of data, for there is, in fact, a very large volume of data. The problem, however, is that a large number of indicators are not considered in the context of their mutual interdependence and mutual interactions. Such an approach produces an "information famine" at the level of regulating bodies, whose consequence is a variety of measures that are carried out with the help of telephones and telegrams as well as special travel assignments that are intended to make information more precise and to make adjustments. In short, a new stream of information is produced which now circulates along official channels.

In addition statistical studies of mass phenomena in the sphere of social relations and of spiritual life, family life, and everyday activities in the USSR call for further improvements. At the present time statistical studies are generally limited to the sphere of economic events and do not answer questions relating to specific linkages between economic phenomena on the one hand and social and spiritual phenomena, how changes in the economy are reflected in social life, influence relations among classes, social groups, collectives and individuals, and alter the behavior and way of living of individuals as well as their thinking. In short, while economic statistics are being supplied to regulatory bodies, an optimal regulation of society also requires social statistics. Without a sociological service within the system of government statistics and a system for the sociological analysis of mass data it is difficult to regulate the whole variety of socio-political and spiritual relations.

The Soviet Union's statistical agencies have been actively engaged in improving the process of collecting and processing statistical information in recent years. Their system of statistical indicators is being improved, the methodological level of information processing is being up-

graded, delays associated with the collection and processing of information are being reduced, while the comprehensiveness and reliability of information is also being improved.

2. OTHER SOURCES OF SOCIAL INFORMATION

Aside from data provided by the social sciences social regulation activities also rely on social information originating from other sources. In particular *social experiments* provide one such source.

Real social experiments presuppose that definite changes in social relations have been produced artificially, in relations bearing on regulation. They are carried out on a relatively small scale and their objective is to study and design effective ways of regulating particular systems with a view to their subsequent introduction into social life. Such experiments either make it possible to improve substantially existing methods of regulation, or else create fundamentally new forms. They identify possibilities for utilizing objective laws of development and concrete historical conditions, optimizing regulation procedures, stimulating the activity of persons, developing and carrying out decisions as well as forms of accounting and of control, improving administrative structures and training personnel, utilizing technical equipment in the field of regulation, and organizing labor activities in a scientific way.

A number of specific factors should be kept in mind in carrying out social experiments. Above all, this refers to the fact that in practice it is not possible to isolate the object of the experiment in a "pure" form and to separate it from wider systems of social relations. Similarly, it is impossible to influence it purposefully in a "pure" way. Every social object is intimately associated with a large number of other objects and is woven into a system of "natural" social linkages that exert a continuous influence on its course of development and its outcome. Beyond this, it is not possible to carry out social experiments at the level of an entire society, since experiments presuppose a change in objectively established social relations. These would be

associated with very large expenditures, both for society itself and for individual collectives and persons. Even carrying out experiments within a relatively limited sphere of social phenomena calls for large-scale organizational and educational activities with the collectives constituting the objects of the experiment, and also frequently presupposes that participating persons abandon existing basic conceptions. Finally there are difficulties in controlling and accounting for all factors that influence the course and outcome of social experiments.

This in no way diminishes, however, the importance of social experiments but merely serves to draw attention to the rigorous requirements that they imply.

Real social experiments are possible only under the following conditions:

- when the social process itself permits changes in the basic modes of operation that produce solutions to the particular problems that are envisaged by such experiments;

- when the required collection, processing, and utilization of social information are feasible, in short, when conditions make it possible to permit a timely access to initial data required by the problem's solution;

- when it is possible to control the course of the experiment and to obtain the necessary information on its course without substantial additional expenditures, beyond those that are associated with the natural course of the process under consideration;

- when changes in the given system's mode of functioning do not produce substantial losses, both for the system as a whole and its individual components and especially for individual persons who may be affected;

- when the specific qualitative characteristics of the system of social relations are preserved.

In the context of a socialist society experiments require above all that artificially produced influences on the social object under study do not conflict with its normal functioning and development and do not produce negative influences on the current and future situation of individuals and of collectives.

Social experiments constitute an important, and occasionally, the only possible means of studying social pheno-

mena generally and especially regulation processes. For within a society, there are many typical systems that are more or less homogeneous in terms of their structure and composition which also possess more or less homogeneous regulation schemes. In the USSR, this includes republics, regions, districts, enterprises, organizations, construction sites, collective farms, and state farms. A sudden shifting of a large number of objects to a new system that has not yet been tested experimentally can result in substantial losses to large numbers of individuals and to society as a whole. It is therefore appropriate to first develop regulation methods in relation to selected groups of typical objects, and then, if they are successful, to apply them to the entire class of such objects.

Social experiments make it possible to study regulation processes in a comprehensive manner. In particular, they make it possible to identify the nature and outcome of activities of a system under the influence of experimental procedures, to identify the resulting responses of persons, their opinions, general disposition, and their evaluation of the innovations in question. These are particularly important factors, since the principal element in regulation concerns the regulation of persons and of their labor and social activities.

The objective of regulating any social object is to achieve an optimal functioning and development of the system. This is inevitably associated, however, with the study of alternative possible solutions, even though each of them may belong to the same type in terms of the objectives that it is intended to achieve. Experiments make it possible to test different alternatives of modes of regulating similar systems in order to select the best for subsequent dissemination.

It is true that it is quite difficult to identify an optimal mode of regulation, for the outcome of an experiment does not exist in a "pure" form. It merely represents the net effect of a number of outcomes produced by the operation of new forms together with old ones, as well as by internal changes within a system and also external influences operating upon it that are all independent of the experiment itself. This, in turn, defines a very difficult problem,

namely to identify within such a net outcome that part which may be attributed to the new mode of regulation. This is possible only if both the external and internal conditions of activity which existed before the experiment are retained during the experimental period. If, on the other hand, that rule is violated, it will not be possible to establish the effectiveness of the experiment and misleading conclusions may be made.

Outcomes of experiments in the field of regulation may be both positive and negative. Negative outcomes are, of course, undesirable since they are harmful to the interests of the members of the collective that is being subjected to experiments. Yet even negative outcomes serve a purpose, in the sense that they may prevent a wide dissemination of forms of regulation that are in fact not justified.

At the present time the method of social experiments is used widely in the USSR, particularly in the field of economic regulation.

Direct communication with the population. In a socialist society, direct communication between leading persons and the working masses serves as an important source of direct as well as reliable information.

Lenin has noted that a systematic approach to the study of public opinion is needed in order to be able "unerringly, on any question, and at any time, to judge the mood, the real aspirations, needs and thoughts of the masses".¹

Direct exchanges of information between responsible persons and those who are led provide a valuable source of information needed for regulation and management. Responsible persons either develop their own decisions or else convey to subordinates decisions of still higher regulation bodies. Such persons also protect and defend the principle of legality itself, moral principles and elements of labor discipline that are embodied in such informational elements as laws, sublegal resolutions, regulations and norms. They serve both as carriers of direct prescriptive information and as organizers of measures to execute decisions as well as controllers over their execution.

Responsible persons concentrate, generalize, and utilize

feedback information, that is information which derives in a systematic manner from those persons who are being led. Exchanges of information between such persons and their subordinates occur continuously in the course of the functioning of a socialist labor collective, as particular orders and instructions are transmitted that are then assimilated by subordinates and are accepted as guidelines for their activities. Subordinates, for their part, report to their leaders their own understanding of their instructions and orders, the manner of their execution, the difficulties that they are encountering, and what must be done in order to carry out the decisions. Frequently subordinates convey their own proposals and undertake a variety of initiatives that are intended to increase the effectiveness of production, improve labor discipline, and criticize shortcomings and mistakes.

The organization of systematic, rational, and comprehensive modes of communication between leaders and their subordinates, exchanges of information among them leading to a systematic perception of the objectives and tasks of the collective and of the general state of affairs within it constitutes a necessary condition for effective leadership under socialism. Leaders must know their subordinates from the point of view of their practical, political, ethical qualities, as well as their interests, objectives, and disposition. Systematic and healthy contacts between leaders and their subordinates contribute to the development of a mutual trust and to solutions of tasks that the collective in question and socialist societies themselves confront. A common access to information together with a juxtaposition of views and a discussion of problems contributes to the finding of solutions that can be understood both by leaders and by their subordinates.

The forms of communication among them vary. They include discussions at general meetings as well as discussions at Party, trade union and Young Communist League meetings and conferences, and reports to individual collectives; meetings devoted to questions and answers; receiving visitors in a manager's office; personal discussions with workers and office personnel; visits to factory shops, sections, individual work stations, rest facilities, dining

¹ V. I. Lenin, *Collected Works*, Vol. 33, p. 192.

halls, and clubs; and visits to workers' families. It is important that such communications be systematic rather than merely occasional and that thought be given beforehand to both their objectives and to the use of those forms of communication that are most appropriate, under given circumstances, for solving particular tasks.

In consulting with the people with a view to making use of their rich experience as well as to inform them about the major events within the country and abroad the Communist Party and the socialist state employ the most varied forms of communication. These include addresses by heads of central and local bodies, open and wide discussions of major legislative proposals and major proposed decisions, reports of various representative bodies to voters, and a systematic publication of data concerning the fulfillment of plans of development and of the outcome of activities at various levels within the social system.

The study of documents, materials, communications, and reports. The study of books, journals, newspapers, of radio and television programs, of reports of Party and state bodies and of economic organizations, as well as of letters and other communications from workers, and also visits to exhibitions, provide a considerable volume of useful information concerning the most diverse aspects of a society's functioning and development. That information makes it possible to make use of successful experiences and avoid negative ones and also to avoid rediscovering that which is already known and to repeat again that which has already been achieved.

In particular, letters and other communications from workers to Party organizations and economic organizations as well as to the editorial offices of newspapers, journals, and radio and television services constitute an important source of social information. They contain information about achievements in the economic and cultural spheres, concerning the experiences of leading organizations, the approval of particular decisions and resolutions, responses to particular events both within the country and abroad, critical comments concerning particular managerial bodies or personnel, analyses of shortcomings and of errors together with suggestions for overcoming them, and valuable

suggestions about the effectiveness of production and improvements in cultural services and in general everyday services.

Because of their personal nature letters reflect the general attitudes, aims, and wants of individuals as well as the socio-psychological climate that exists within collectives and the attitudes of individuals towards decisions, managerial bodies, and managerial personnel.

Because each letter represents a person, attentiveness towards letters constitutes attentiveness to individuals. This is one of the characteristic traits of a socialist order.

Generally, each specific letter reflects unique facts and unique situations. By comparing and grouping letters, however, it is possible to identify particular general trends that manifest themselves within unique phenomena. This constitutes an essential element of regulation and management.

Letters from workers received by *Pravda* provide a basis for still more general information.

In 1977 the editors of *Pravda* received 570 thousand letters from readers. Twice a month some of these letters are published as a basis for a series of newspaper campaigns on such themes as, for example, "We Are the Soviet People", "Work Discipline", "The Moral Climate of the Working Collective", "Party Life: What Should Be the Nature of Controls", "Leninist Style of Work", "Out in Front" (about the activities of Party organizations), "The Quality of Goods" and "Leisure Time".

Each year more than 120 resumé of readers' letters are sent to Party and Soviet bodies, ministries and departments. They contain summaries describing the state of everyday general services and supplies, housing problems, overspending, and shortcomings in the work of Party and Soviet bodies. Some of these summaries contain an analysis of the character of the letters that are received from various regions and republics.

Each year *Pravda's* Editorial Board receives 12 thousand visitors.

The Communist Party attaches great importance to such work with letters from working people. In the CPSU Central Committee's resolution entitled "On Improvement in the Study of Letters and in the Organization of Receiving

Working People" (August 1967) it was noted that letters received from workers serve as one of the important forms of consolidating and expanding the ties of the Party with the people, of the population's participation in the managing of state affairs, as a means for expressing public opinion and as a source of information concerning the country's life. This thought is also emphasized in a resolution adopted in May 1976. This relates to the further improvement of work with letters from workers in the light of the decisions adopted by the 25th Congress of the CPSU.

Similarly both written and verbal reports contain information that is needed to control the implementation of decisions. Caution is appropriate, however, towards reports that are often extensive in terms of the volume but contain masses of useless information. The preparation of voluminous reports requires the time of many persons and constitutes a non-rational expenditure of time and resources.

Information conveyed from below is not limited to feedback information making it possible to adjust the activities of managerial bodies. For in addition, an important part of that information constitutes initial and primary information. It contains those communications about facts, events, and general attitudes, activities and behavior of individual persons that serve as a basis for the taking of decisions and for new regulation cycles resulting from such decisions.

Information from below moves along two streams. One of them is a purposeful and planned collection and analysis of information by Party and state bodies as well as scientific institutions and also by radio, press, and television services. Another conveys a spontaneous transmission of information from individual persons and primary units into Party, government and economic bodies, and into bodies concerned with mass communications media. Eventually both streams merge as the information that they carry is studied, processed, and utilized in assisting regulation and managerial activities.

It should be noted that in the sphere of mass information the classification of participants in information interactions into information sources (regulation subjects) and information receivers (objects of regulation) is in fact a

relative matter. This is because both sides of such interaction are both subjects and objects of information operations simultaneously. It is only by analyzing individual instances of such interactions that it is possible to establish who, in fact, is the source of influence and who is influenced. In such a context those who are regulated in a socialist society also participate in regulation, since they operate as the sources of the information that is subsequently employed in preparing and taking decisions.

In practice the sources that have been mentioned are often employed jointly or else in various combinations rather than individually.

3. INFORMATION AND AMPLIFICATION OF INTERACTIONS AMONG SOCIAL AND NATURAL SCIENCES

It has just been noted that it is the social sciences and primarily Marxist sociology that provide the principal source of social information. Marxist sociology, however, is not a collection of established conclusions and propositions, laws and categories that never change. It is a creative science that develops continuously on the basis of generalizations of the newest achievements in the revolutionary struggle and the practical construction of socialism and communism, as well as of the newest achievements in the social and natural sciences. Marxist sociology generally and the theory of a social regulation in particular cannot be limited to a framework of methods and means of study that are given for all times. In order to serve as a reliable scientific basis for the regulation of a socialist society, still newer and more precise methods must continually be added to its methodological equipment. The necessary condition for scientific regulation is an approach to social phenomena in terms of criteria that are as rigorous as those that are employed with regard to natural phenomena. In this connection it is important to recognize that the process of integration among sciences that is progressively taking place is not limited to either the framework of natural sciences proper or that of the social sciences but is rather creating

linkages between both. In particular the process of formalization and mathematization of knowledge is an inherent attribute of the social sciences, and methods of study that have been developed by the natural sciences are finding increasingly wider applications. Such an integration of knowledge about society and knowledge about nature is especially visible in the field of social information and regulation.

In particular cybernetics has already played a very large role in solving numerous problems related to the further improvement of information processes serving the regulation of socialist society.

Cybernetics itself is of course a complex science. One of its branches is concerned with general problems of regulation and with problems bearing on the organization of information within different systems. Another is associated with electronics and computer technology, as well as the automation of production and management. A third is concerned with particular branches of mathematics and of theoretical physics. All three, however, are contributing to the theory and practice of social regulation.

The principal merit of cybernetics is that it has applied achievements in sociology, mathematics, biology, and a number of technical and other sciences in identifying certain general traits and attributes of regulation in biological and social as well as technical systems. In particular it has shown that in such systems regulation processes rest on complex networks of nonlinear causal relations; that regulation possesses an inherently antientropic character and serves to oppose both external and internal factors that perturb particular systems; that regulation is goal-oriented in terms of its direction and that its ultimate objective, which constitutes the ultimate problem of regulation, is an optimization of the system's functioning; that regulation is intimately associated with information operating as a source of signals in the sense that such signals are based on feedback relations that constitute one of the basic principles of all regulation.

There is no doubt that these general laws and principles are also inherent in the regulation of social systems and that the theory and practice of the scientific regulation of

society must take them into account. It is impossible to conceive of social regulation without such concepts of theoretical cybernetics as "information", "feedback relations", "signals", "perturbing factors" and "the optimization of regulation processes" among many others.

Cybernetics contributes precise quantitative methods to the theory of social regulation for analyzing regulation processes and especially for analyzing social information, which is an inherent attribute of regulation.

Both social systems and the regulation processes that are associated with them possess specific cybernetic properties associated with the collection, storage, processing, transmission, and utilization of information. It is not possible to identify and study these properties nor to apply information for purposes of optimizing regulatory processes without the help of cybernetics. But that is only one side of the matter. The other concerns the fact that it is equally impossible to organize information processes and the regulation of society rationally without a Marxist-Leninist sociological analysis. For only Marxist sociology is able to provide a qualitative evaluation of information, to identify its class essence and the purpose and objectives for which it is employed. The field of social information thus serves as a juncture of sociological and cybernetic knowledge.

Cybernetics provides an important means for overcoming the increasingly comprehensive contradictions between the rapid growth in volume of information, and the accompanying difficulties in processing it, on the one hand, and the increasingly urgent need for providing information services to all spheres of human activity, on the other, and especially to processes of social regulation.

There are many objects and subjects of regulation within a society (sectors, cities, districts, enterprises, and regulation bodies) that are very similar in both a structural and functional sense. A cybernetic analysis is therefore able to provide certain general scientifically-based schemes and regulation algorithms, to identify optimal dimensions of individual objects from the point of view of their capacity for regulation, and to establish requirements for personnel and other important parameters on the basis of exact quantitative measures rather than of "common sense".

Yet while recognizing the very great role of cybernetics in the further development of socialist regulation it should not be forgotten that cybernetics is a specific science which studies regulation processes from a particular structural-functional and quantitative point of view without regard for the qualitative nature and contents of the system within which these processes are taking place. Cybernetics is therefore not able to encompass all the knowledge that is relevant to social regulation, not to mention the corresponding methodological and theoretical foundations.

Attempts by bourgeois scientists to describe cybernetics as the general methodological basis for social regulation, and to substitute it for Marxist-Leninist methodology are insolvent. They are based on a failure to understand or else a misrepresentation of the essence of both cybernetics and of Marxism-Leninism. Cybernetics encompasses an extremely wide range of information and regulation processes and identifies their quantitative characteristics. But it is not able to provide a comprehensive, qualitative analysis of these processes. It is for this reason that the cybernetic analysis of regulation processes should itself be based on the methodology of Marxism-Leninism.

It is not possible to understand regulation processes in societies without comprehensive sociological analysis and without identifying the qualitatively specific features of social systems that determine the contents and principles as well as the boundaries of regulation and regulation means.

Soviet scientists are currently engaged in an intensive search for ways to "cyberneticize" regulation and to apply the findings of cybernetics to the theory of social regulation.

In particular we have recently witnessed the birth of a new science, namely economic cybernetics, which constitutes an organic synthesis of social, natural, and technical sciences. It is destined to play an enormous role in the further improvement of economic regulation. Through the application of mathematical methods and of computers it contributes to a better utilization of material, labor, and financial resources, to the improvement of proportions, the location of various production processes and of supply acti-

vities, and to the measurement of both expenditures on the national economy and the results that they produce.

The increasingly wide and comprehensive influence of mathematical methods in the most varied sciences, including sociology and social information, is yet another characteristic trait of contemporary knowledge.

This influence in sociology is explained by the unity of nature and society and by the presence of quantitative as well as of qualitative characteristics in social phenomena. It is also explained by the great level of abstraction and very wide scope of the principles on which mathematics itself is based and which make possible its application to the social sciences as well. In particular, mathematical deduction is especially important in organizing information and in the regulation processes, for whenever there exist regulation systems that are more or less similar (and there are many such examples among social objects) mathematics makes it possible to find a general formula or regulation algorithm that may then be used in regulating all objects of a similar type.

The study of quantitative characteristics of various social objects and their expression in terms of mathematics make it possible to understand the qualitative features of social phenomena more deeply, to view them theoretically, and thus to regulate them or influence them more effectively. It should also be noted that quantitative indicators need not be numerical in form. For mathematics possesses an entire range of concepts (models, matrices, functions, graphs, forms, relations, symbols) that are able to express certain qualitative traits of social phenomena as well as quantitative ones, and to identify extremely complex interactions within a set of social factors, thus providing the type of complex information that is so much needed in the sphere of social regulation.

Scientific approaches to the regulation of society presuppose a rigorous consideration of the interaction of the most varied and frequently contradictory factors that influence the course of development of social processes. This calls for their quantitative as well as their qualitative analysis and for the identification of specific numerical indicators (such as schedules, rates, results, levels, degrees,

intensity). It is not possible to solve these problems without applying mathematical methods and without developing and applying specific methodologies and means for expressing social processes in terms of quantitative indicators. It is this which makes it necessary to develop a comprehensive methodology for translating social phenomena into the language of mathematics and for formalizing all social phenomena as well as expressing them in terms of metrics, quanta and gradations.

It is impossible, of course, to express all social phenomena through the language of mathematics, nor is there any need for this. Above all, it is necessary to express mathematically those parameters of social systems that bear on their effective regulation, i.e., mass relations and functions that are stable and recurring.

The development of a conceptual framework that is suitable for a description of social objects is a new and difficult task since contemporary mathematics has developed in the context of applications to natural processes. Yet within the framework of mathematics, there already exist a number of disciplines that are being applied successfully to studies of social information and social regulation. These include the theory of operations research, the theory of queues, the theory of strategic games, linear and dynamic programming, the theory of optimal processes, and mathematical statistics.

An increasing role in regulation is played by modeling through the use of mathematical methods and of computers. Since it is quite difficult to carry out real experiments in the field of regulation, particularly on a large scale, it is often appropriate to first carry out a mathematical experiment on paper, so to speak, and then, in the event that it is successful to implement the results that it suggests in actual life.

Applications of mathematical methods to studies of social information and of social regulation require that provision be made for at least the following conditions:

a sufficient state of development of that field of social sciences within which mathematical methods are employed;

the availability of the needed volume and measure of reliability of information concerning the system whose re-

gulation process is formalized through the use of mathematical methods, and of programs for processing that information;

the existence of an integrated easily processable mathematical documentation and, more generally, an adequate capacity of a system to lend itself to quantitative analysis and description;

the availability of a definite assortment of mathematical means (such as graphs, equations, etc.), that are suitable for an analysis of social information and for simulating regulation processes or at least for identifying a firm foundation for constructing the corresponding models;

the availability of specialists in organization, sociologists, economists, and specialists in law who are able to apply mathematical methods for processing social information.

While there is a need for a wider application of modern methods derived from the natural and technical sciences to studies of social information, and in particular, of mathematical methods, it is also important to avoid an excessive emphasis on such methods. It should be recalled that the natural and technical sciences merely serve as auxiliary means in facilitating man's decisions concerning regulation problems and that their applications should be both closely associated with qualitative and sociological analyses of social systems and based on a rigorous recognition of the laws governing the functioning and development of societies that are identified by Marxist-Leninist science.

It has already been noted that as a rule it is the qualitative aspect of social information, which does not lend itself to formalization, that plays a leading role, and that it is associated with the position of individuals, of social groups and of classes in society, with their interests and needs, and the motivations for their behavior and for their activities, as well as their emotional and psychological state and social experience. It follows that it is specifically sociological methods rather than mathematical or formal logical methods and methods employed in the natural sciences that play a leading role in obtaining, analyzing and processing information.

THE ROLE OF INFORMATION IN THE REGULATION OF SOCIETY

1. THE UNITY OF REGULATION AND INFORMATION

It has already been emphasized that regulation is intimately associated with *information, i.e., the course of information processes*. The continuous circulation of information among a system's components and between the system as a whole and its environment constitutes a necessary attribute of regulation. It is precisely because of information processes that a system is able to carry out purposeful interactions with environmental conditions and to coordinate and subordinate relations of its components and channel both their movement and its own motion towards a preprogrammed objective. As a result of self-regulation, a system is able to retain its integrity and its qualitative specific character and frequently (especially in the case of social systems) not only preserve itself but also improve itself and develop.

The science that is concerned with the most general laws governing regulation processes is cybernetics. Its major representatives, moreover, view it above all as a science about the flow of information processes. In particular, Academician V. M. Glushkov, a Soviet cybernetician, defines that subject as the science that is concerned with general laws governing the transformation of information in complex regulation systems. Accordingly, he conceives a regulation system as an arrangement that carries out an ordered transmission and transformation of information so that it may acquire the particular form that it needs for serving regulation processes.

Similarly, Academician A. N. Kolmogorov associates cybernetics and regulation processes with information. He defines cybernetics as the science that is concerned with methods of perceiving, storing, processing and using information.

Cybernetics has identified the role of information as *signals* which are employed in the regulation of dynamic systems. It has shown that such a signal form of information constitutes a necessary trait of regulation processes. In the view of A. N. Kolmogorov, regulation is a transformation of information into signals that guide the activities of machines and of organisms. In such a context, signals refer to the physical processes that convey information. They refer to the particular energy operations that are necessary and sufficient to carry out regulatory processes, and in order that self-regulating systems may function in opposing perturbing influences and preserving their essential characteristics.

It is important that when signals are received, amplified and transformed, the information content that they carry, i.e., the meaning of "commands", not be distorted or else that their distortion remain within acceptable limits. Otherwise, a "command" will bring about a violation of the function of a system or even its destruction rather than an adequate response. In such a context, it is characteristic that self-regulating systems react only to some types of information and some signals and contents, namely, to those that correspond to the nature of the system and which are needed for its regulation at a given time and in given conditions.

The signal form of information constitutes an antipode to entropy processes, that is, to the tendency of a system left to itself to move from less probable states to more probable ones, and from organization to disorder. An opposition to entropy processes is the most general form of the essence of regulation processes and of purposeful operations of systems. Signals convey "commands" to systems which, if they correspond to the system's nature and are perceived, will cause it to react in ways that correct its behavior, thus assimilating or else neutralizing perturbing operations.

Cybernetics has not only brought out the unity of regulation and information processes, but has also shown the common nature of information processes of different self-regulating systems. In such a context it has synthesized a number of theories, including information theory, the theory of algorithms, and the theory of automatic control, and has provided an effective method for studying self-regulating systems, namely modeling. It has also contributed to the enrichment of the pragmatic and semantic as well as the syntactical aspects of information.

Having established the unity of regulation and information, cybernetics views both without reference to content or to a system's qualitative specifics. Cybernetic analyses of the regulation and information processes that characterize individual systems are therefore made substantially more concrete, more comprehensive and also related to basic principles through specific analyses that identify the qualitative essence and nature of a system. Such concrete analyses and studies of processes of regulation and information in society are especially important, since social systems are governed by laws of behavior that are highly specific and that cybernetics is not able to identify. Instead, a Marxist-Leninist sociological analysis is needed together with the assortment of means that are inherent to Marxism-Leninism's dialectical materialistic methodology.

The very appearance of information theory in the 1940s has been of great importance for studies of regulation processes in society and of their organization. For in such processes one finds not the strict one-to-one determinism but rather many-to-one nonlinear causal relations. In this connection information theory represents a generalization of probabilistic principles and a transition of science from the construction of logical schemes based on rigid determination to more flexible schemes that include elements of probability. As a result, both in science and in practical regulation activities, a probabilistic or "informational" style has been increasingly evident. This makes it possible to identify more comprehensively the internal complexity of social systems, which is not strictly defined by specific external circumstances. It also makes it possible to study the relative autonomy of subsystems within a more com-

prehensive integrated system in ways that take into account the statistical nature of both internal and external perturbances; to study trends in perturbing processes and take them into account in designing correction operations; and to identify alternative decisions and then select the best among them. In short, such a statistical "information-oriented" style lends a more scientific character to regulation activities in which the enormous complexity of social systems and of regulation processes within them is taken into account. It also contributes to more flexible regulation activities that correspond to the rapidity and instability of social events.

The term *scientific regulation* refers to a conscious operation on the part of a regulating subsystem on a social object (regulated subsystem) that is based on reliable knowledge and seeks to provide for its effective functioning and development and to achieve a specified objective.

In such a context the role of social objects may be assumed by enterprises, production associations, economic sectors, the economy, other spheres of social life, or else society as a whole. Each of these belongs to the class of large mixed systems (mixed in the sense that they contain both human and material components).

Both society as a whole and any of its subsystems are extremely complex and diverse in terms of the number and quality of their components (for which similarly diverse interactions or linkages exist) and also in terms of their position within a social system, the nature of the functions that they perform, and the properties of interactions with extremely large numbers of diverse external factors. It is important to emphasize, moreover, that social systems continually experience the influence of external as well as of internal perturbances.

Perturbing influences (entropic factors) operating on the system are extremely varied. The power and capacity of some of them may be low and may be applied over short time intervals, while others, even though their power is small, may operate continuously or over prolonged time intervals. Yet neither of these seriously influence the system's structure and functions, for timely operational information concerning these influences makes it possible to sta-

bilize the system in the first case and to adapt it in the second.

There are also influences, however, that destroy the structure of an overall system or else of its individual components and interfere with the performance of their functions. It is then the task of the subject of regulation to provide for a reorganization of structure and functions in order to preserve the particular qualities that are specific of the given system, and to maintain its functioning. This calls for information that is both more complex and more diverse than the one required for the stabilization and adaptation of systems. More specifically, it requires information about the internal state of the system and its resources and its capacities for recreating the structures and functions that have been destroyed, as well as information about the sources of perturbation themselves. It is important to note that the stabilization, adaptation, and self-reconstruction of systems in situations in which perturbing factors continue to operate, are a prerequisite for their further improvement and development.

W. Ross Ashby has noted that "...only variety can destroy variety".¹ This means that the variety of perturbing activities can be perceived by a system, analyzed and filtered only when variety also exists in the corresponding regulating system (in the case of society this refers to the subject of regulation). A regulating system must be prepared to perceive a variety of perturbances and to block and not admit those elements of variety that may interfere with the system's normal functioning and especially those that could destroy it, while allowing and assimilating those environmental elements that are useful to it and contribute to the preservation of its qualitative integrity and its normal functioning, as well as to its further improvement and development. A system's capacity to perceive that which is useful and interfere with that which is harmful depends on the extent to which it is informed, and on the extent to which its past experience in interactions with its environment and in

¹ W. Ross Ashby, *An Introduction to Cybernetics*, London, 1957, p. 207.

meeting problem situations associated with perturbing activities is stored within its information resources. The greater the diversity of past experience and the corresponding information within which it is stored, the more stable and the more flexible will be the system and the greater will be the range of perturbances that it will be able to filter.

It is the task and essence of a regulating subsystem or subject of regulation to distinguish between valuable information and noise or useless or else harmful perturbances. In short its task is to select from the variety of information to which the system is subjected that part which makes it possible for the system to continue to exist and develop.

Regulation activities thus produce a transition of external perturbances into elements that become internal for the system. This constitutes a reduction and a limitation of external variety and a simultaneous expansion of internal variety and of the volume and diversity of internal information through the assimilation of external perturbances that are in fact useful.

It is on the basis of requisite variety that self-regulating systems, including social systems, function. This refers to the establishing of a proportion among a variety of external perturbances and the system's internal variety, in short, between external information and the system's own internal store of information.

As the volume of external information increases there must be a corresponding increase of internal information. In cases when there is a correspondence between external and internal information, the regulating subsystem is perfect since it is able to adequately respond to perturbing influences. Such a degree of perfection can exist only when stability exists in the system's environment, producing a stability of both perturbing influences and in corresponding responses. Such a stability usually does exist within technical systems and such systems are therefore quite stable and able to carry out their functions over prolonged periods of time.

Social systems, on the other hand, are another matter. They exist within conditions in which the environment continuously changes and in which the variety of perturbing

influences continually grows together with the variety of information influencing the system. In such conditions a system will be sensitive to fluctuations in the amount of variety that it experiences. At the same time it will not be possible to find a more or less prolonged, and even less absolute correspondence between external and internal information, and hence, a prolonged and even less absolute state of perfection of the regulation subject. Instead one always finds a contradiction and a lack of correspondence between external elements and internal ones and between external and internal information. This, in turn, makes it necessary to continuously perfect the regulation system and to bring it to the level of the requirements of the times and of the given historical stage of social development.

Technical self-regulating systems (cybernetic systems) are not able to autonomously change their own variety so that it correspond to the variety in their environment. They do not perceive and assimilate external information and do not accumulate it and use it in order to perfect and develop themselves and are thus only capable of elementary adaptation.

Society and social systems are another matter. As they function and develop in the context of a continuously changing environment they are themselves unusually mobile and perceptive in the sense that they are able not only to perceive factors in their external environment and external information in order to preserve themselves, but also to assimilate matter, energy, and information in volumes exceeding the needs of self-protection and of simple reproduction. In this way they produce an accumulation of matter, energy, and information which are then expended on the system's own further improvement and development. External information is then assimilated and transformed into internal information. As a result, the system's internal variety is increased, and this, in turn, makes it able to perceive an even greater measure of external variety. Thus the system's stability and mobility increase as it continuously improves and develops.

In taking decisions regulation bodies or persons responsible for regulation must be well informed of the following:

the essence and concrete manifestations of objective laws operating in the sphere of social life that enters into the sphere of competence of the particular body, as well as the mechanisms through which these laws operate and the methods and forms that must be applied in order to utilize them successfully in carrying out the tasks of regulation;

the general objectives that the given society confronts at a given stage of its development as well as the tasks that the regulation body is to carry out in order to contribute to the achievement of general objectives;

the internal state of the object of regulation and its environment, and possible positive and negative influences on the object of regulation as well as the capacity and ability of individuals to carry out the tasks that they are given;

the methods and means of regulation that should be utilized in order to bring about an effective functioning of the specific system and the achievement of specified objectives.

Regulation is a continuous goal-oriented process of influencing a system. And that influencing cannot cease. The continuity of the process of regulation is made possible by the continuity of information movements. The subject of regulation is able to influence the system being regulated only because it continuously receives information about its state as well as the state of the external environment, and about deviations in the movement of the system towards specified objectives, processes that information into decisions and commands, and transmits it to the object of regulation, correcting its behavior and bringing about the fulfilment of specified programs.

Each regulation cycle begins with the collection and processing of information and ends with a receiving of information that serves as the initial point for a new regulation cycle. The development of a strategy of regulation (of long-term objectives and tasks), the formulation and selection of regulatory decisions and the organization of measures to carry them out, as well as regulation and control and surveys of outcomes are all based on the utilization of information, and in turn, produce new information.

In short, *it is not possible to separate the regulation of a society from a continuous process of production and reproduction of social information.* That process presupposes:

an accumulation and storing of information produced by preceding generations;

an assimilation by the present generation of accumulated information (training, education);

a forecasting and planning of the production and production of information proper (scientific studies, inventions, discoveries, generalizations of practical experience in the sphere of production, socio-political relations and spiritual life);

a collection and selection of information needed for regulation and its evaluation;

an analytical-synthetic processing of information (bibliographic descriptions, classifications, listing by subjects, annotation, abstracts, translations, coding operations);

the storage and search of information;

photographing, xeroxing, and duplicating;

the dissemination, propagation and transmittal of information to users;

the utilization of information;

control over the effectiveness of the utilization of information.¹

Thus regulation is intimately associated with information and with the flow of information processes. Without information it is not possible to regulate a system effectively and to bring about its rational functioning and successful development nor the achievement of the objectives that it is assigned. In such a context, information solves three classes of problems within regulation:

it is a specific form of mutual linkages and mutual interactions among system components as well as between the system as a whole and its environment;

it serves all levels and functions of regulation—from formulating and taking decisions to surveys of their outcomes;

it constitutes a direct cause that determines the selection by a system of a particular alternative form of behavior and

¹ Aside from minor changes, this scheme is borrowed from M. Bagrad's study entitled, *Nauchnoye upravleniye obshchestvom v aspekte klassifikatsii ego strukturnykh elementov* (The Scientific Regulation of Society from the Point of View of a Classification of Its Structural Elements), Riga, 1973, pp. 11-12.

its transition to a new state, serving its movement towards a specified objective.

An absence of reliable information is a source of subjectivism and of purely voluntaristic decisions and actions that are incompatible with scientific regulation. It is therefore natural that the collection and processing of information and its effective utilization constitute a necessary and essential trait of regulation that occurs *at all its levels and in all its functions*.

Yet, it would be an error to reduce regulation to a movement of information. For the regulation of production or of society is an exceedingly complex process that is associated with the conscious activities of persons and collectives, and with large-scale organizational activities intended to prepare the ground for decisions and subsequently bring about their fulfilment, as well as with organizational activities concerned with a system's regulation and control and an accounting of the consequences of its functioning. Information constitutes a guiding thread, as it were, that serves to guide persons within the very complex labyrinth of social phenomena and to influence them as well as to make use of social and natural forces and to achieve designated objectives.

Information, moreover, is only one of the means of influencing a system, whether this is an enterprise, a sector, an economy, or society as a whole, and it operates together with others, that include stimulation, the placing of a system in situations that force it to operate in specific directions, and different types of sanctions, etc. It is true, of course, that all other means of influencing also require a certain volume of information, that information represents only the form that is assumed by a particular means, and that it does not operate as directly as in the case of direct information actions.

Aside from this, information may be as full, reliable, and timely as one may wish, but if persons are not ready to make use of it and if procedures for taking decisions on the basis of information have not been developed and individual functions have not been assigned to regulation bodies and individuals with sufficient precision, then regulation will not be effective,

2. INFORMATION AND REGULATION SYSTEMS

Persons who are engaged in the direct production and transformation of matter and energy into objects able to satisfy human needs carry out a dual type of interaction with matter and energy and with objects of labor and means of labor. The first is an *informational* interaction (through the brain and the nervous system); and the second is *mechanical* interaction (through organs of the bone and muscle system). The information interaction, moreover, anticipates and precedes mechanical interaction. Indeed, in order to transform a substance (an object of labor) man as a producer must know the properties of that substance and the manner in which operations may be carried out. He must know means of influencing it, their possibilities, ways in which they may be employed, and must compare the results of his operations with the objective that has been specified and correct mechanical operations in the event that the information received indicates that there is a lack of correspondence between the results and the objective, and that operations have not yet brought about an achievement of objective. The difference between the objective and the results that have been achieved in mechanical operations constitutes that *information signal* which, when it is received and understood by the producer, serves as a basis for determining the nature of the further mechanical operations on the object of labor.

Essentially, the entire production process is formed of elementary information and mechanical interactions of this type among individual producers and their instruments and objects of labor. These interactions take place in the context of the elementary "man-machine" system which constitutes, in turn, an element of the "society-production" system. The elements of the "man-machine" system, moreover, differ in terms of their quality, both from the properties of man and from those of machines. Similarly persons entering into a "man-machine" system differ from each other in terms of the informational-logical, mechanical, and regulating functions that they perform. In short they are persons of different professions. Finally, the nature of operations

performed by machines on objects of labor also differ, as do their outcomes.

It is important to keep in mind that there exists an hierarchically organized *administrative regulation system* over the combined elementary "man-machine" systems, and that it coordinates and executes sequentially the functions of elementary systems, and exchanges of the results of their functioning at the level of production shops, enterprises, and associations. Within the framework of such large-scale systems both horizontal and vertical interactions among their components appear as informational-logical interactions which represent the substance of organizational regulatory relations.

At the same time organizational regulation systems represent particular networks of communication channels, that is, communication networks for regulation. These do not refer, however, to the usual physical lines of communication, but rather to cybernetic and informational communication lines which provide for a mutual understanding among regulation subjects at various levels, and which bring about mutual interactions among the various "man-machine" systems that are directly engaged in the production of material goods.

Within a set of various "man-machine" systems it is ultimately the specially organized informational interactions among them which are carried out by regulation subjects at various levels that constitute the very complex social organism called production. Subjects of regulation process enormous volumes of information in accordance with programs that determine the movement of the particular systems for whose regulation they are responsible under socialism, ranging from enterprises to the economy as a whole. It is the set of subjects of regulation interacting informationally and carrying out a coordination and subordination of the functions of various levels within the economy that constitutes the economic regulation system.

While economic regulation is the principal type of regulation in society, it does not encompass the full variety of social regulation structures and processes.

In this connection Ya. N. Khanelis writes that "social regulation represents a system with many contours that

encompasses the entire structure of the basis and superstructure. The principal contours of social regulation are: economic, political, administrative and legal, cultural and ideological, and scientific and technological".¹ In agreeing with the author, we would also add an additional contour, namely, the social contour (in the narrow sense of that term).

Each contour possesses its own specific characteristics and is associated with all others through a great diversity of relationships, among which informational linkages play an important role. Within any given contour, regulation requires specific information encompassing the corresponding sphere of social life. In the case of economic regulation, this will be economic information, while in the case of political regulation, it will be political information. Specifically economic information is not sufficient, however, for economic regulation itself. Persons who are engaged in labor and in collectives are associated with each other not only through economic but also social relations. The latter are characterized by their specific levels of culture, and their activities are guided by specific ideals. Economic regulation thus requires not only economic but also all other basic types of social information. Similarly, the regulation of society, as a whole, requires appropriate linkages of all types of social information.

The extremely complex multilevel regulation system that functions in Soviet society represents a combined set of state, economic, and social organizations and is headed by the Communist Party. In order that each of the regulation system's links may carry out its functions effectively, each of them must be provided with the corresponding information. The needs of individual regulation links (subjects) for information vary and are primarily determined by the particular regulation tasks that specific regulation subjects or particular members of the administrative structure carry out, that is, by the particular functions that they fulfil. Such needs are always specific, since the tasks confronting regulation are themselves specific.

¹ Ya. N. Khanelis, *Operativnoye ekonomicheskoye upravleniye i informatsiya* (Operational Economic Regulation and Information), Moscow, 1971, p. 10.

In addition, the volume and content of information required by various regulation subjects depend on the following factors:

the scope and importance of the decisions being taken (the larger their scope and the greater their importance, the larger will be the volume and content variety of the information that is needed for formulating and taking decisions);

the number and nature of regulation parameters (the greater the number of such parameters and the more complex and multifactoral they are, the greater will be the needed volume of information and its variety);

the duration and frequency of the regulation cycle and the frequency of the regulation activities;

the number of possible alternative states and behavior modes of the system;

the intensity and variety of the internal and external perturbances to which the system is subjected;

the number and quality of the indicators that describe the outcome of a system's operation.

Finally, the volume and contents of the required information depend in many ways on the structure of the regulation system itself and the relative importance of centralization and decentralization. It is that proportion which determines the number of degrees of freedom that exist in the taking of decisions at various levels of regulation. The higher the degree of centralization, the larger will be the volume of information that is needed by the higher regulation levels.

It is important to note that it is not possible to attach an absolute value to centralization, and that it possesses its limits, which, to an important extent, are determined by the inability of the center, that is of the highest level, to process information needed for taking decisions on all regulation matters. It is for this reason that within the framework of a centrally planned regulation of the economy and of all social life, a process of gradual decentralization of regulation is taking place in Soviet society which provides for a redistribution of functions to lower levels and to an increasingly wide number of organizations and persons. Decision-taking powers are given to a growing number of or-

ganizations and persons, and this results in a corresponding redistribution of information. Increasing volumes of information remain at lower regulation levels where an increasing number of decisions are being taken.

A substantial redistribution of information is currently taking place in connection with the rationalization of regulation and the overcoming of excessive numbers of levels through a reliance on a two- or three-level system of economic regulation. Production associations which serve increasingly as the principal accounting unit within the economy, have become a focal point of information needed for operational regulation. Strategic information, on the other hand, is concentrated in ministries. Such a replacement of the multilevel regulation system also increases the rate at which information circulates and eliminates intermediate modes for concentrating it and processing it.

The development of information follows that of the regulating system and processes of regulation. New principles and methods of regulation necessarily produce changes in information, in its contents, directions, flows and data banks, as well as in the form in which it is received, processed, transmitted, and utilized. As regulation programs are changed, so is information.

Similarly the movement of information flows also corresponds to the structure of regulation systems (subjects of regulation). Within a *linear* structure (in which the regulation subject possesses one upper level and several lower levels) information moves from level to level along a single communications channel. Yet such a structure, together with its one channel movement of information, can only serve regulation activities concerned with a limited number of aspects of a relatively simple regulation object. Within a linear structure, a subordinate level always addresses itself to a single regulation level. In a situation in which the number of issues being resolved is large this produces an informational overload for the regulation level that is then not able to process and fully utilize the information that it receives. As the capacity for regulation is exceeded, moreover, there arises a need for organizing new links and levels of regulation and hence for coordinating their work. The danger of bureaucracy then appears and of unnecessary de-

lays in the movement of information. These factors make linear structures and corresponding information services ineffective whenever complex systems are being regulated.

Some of the shortcomings of a linear regulation structure are overcome by a *functional* structure, in which subunits of the regulation subject specialize in particular questions. The overall volume of information is then divided into specialized subflows, whose movement then proceeds along several communications channels. This serves to increase the coefficient of effectiveness of information and makes it possible to take responsible decisions. Yet such functional systems, too, possess shortcomings. For lower level units are then exposed to several flows of command information and there may be occasions on which they will not know which of them should be given priority. This produces a need for coordinating the activities of functional subunits with the corresponding movement of additional flows of information.

Mixed or *combined* regulation structures are the ones that are most widespread. In particular, the linear-staff structure is one of the frequently used mixed forms. It is based on a linear structure within which each level possesses a staff consisting of subunits that specialize in specific problems. Such staff receive and process information on the basis of which decisions are then taken. The decisions are approved by persons responsible for regulation and are transmitted to subordinates in the form of a directive document containing information. While this reduces the informational overload to which such persons are subjected that overload continues to be very substantial. As a result they may sign decisions without considering the essence of the corresponding issue. The quality and effectiveness of the utilization of information then largely depend on the competence of staff workers and of specialists who are directly engaged in the use of information and in preparing decisions.

Under the linear-staff structure reporting information is addressed to the staff along a single channel and is divided there into specialized streams. Subsequently, when it acquires the form of decision projects, it is again entered into a single channel leading to the responsible person. The lat-

ter is thus spared the need to study and analyze the entire reporting information, but he does study and correct all directive information.

Among combined structures the one that is most widely used is that of *limited functionalism*. There, staff subunits take decisions on a specific range of issues whose execution is mandatory to the corresponding subunits at the next lower level. Under limited functionalism the movement of information within structures is generally similar to that in linear-staff structures. It differs in that only a part of the reporting information and only a part of the directive information reaches the level of the responsible director. A substantial part of both types of information does not move upwards beyond specific staff subunits. Reporting information is forwarded to staff subunits along a number of specialized channels. There it is processed and given the form of directives and decisions, some of which are directly forwarded to corresponding subunits at a lower level, while others reach these lower levels through the responsible directors at a higher level.

New types of structures have been created increasingly in recent years. This is true, for example, of temporary structures that are created for a limited period of time, as well as of structures created for regulating a particular project, structures for program planning, interagency structures, and matrix structures. In all such cases, the movement of information is altered in appropriate ways.

While the volume, content, direction of flows, delays, and intervals of circulation of information differ in different social systems, there do exist general rules relating to the organization of information which presuppose answers to the following questions:

what is the nature of the primary information that is needed for taking decisions;

in what type of informational documents are the decisions embodied;

through what means is the primary directive information conveyed to the object of regulation and to executives;

what type of information relating to the course and outcome of the execution of a decision should be given to the regulating body by different sectors of the regulated object;

who is responsible for giving that information, at what time and under what conditions;

in what way is this information formalized and through what channels is it transmitted;

for whom is this information intended and in what volume and assortment is it conveyed to various subunits of the regulation subject, that is, to responsible officials at various levels;

what are the ways and means for assuring timely access to reliable information, for controlling its communication and verifying its reliability;

what place, methods, technical facilities, and personnel have been assigned for working with information being received from regulation objects, what are the means for storing, processing, and utilizing information;

who are the persons taking decisions on the basis of such information, or else adjusting earlier decisions;

what are the forms of directive or regulating information, what is the frequency of its transmission, who are the receivers and executives, and what delays occur in conveying it to executives.

In order that information may be effectively employed in regulation it is necessary that it lend itself to communication, i.e., that it be understandable and acceptable to the person being informed. As a rule, the communicability of information is ensured in the communication itself. Frequently, however, it is actualized after the communication has been received. For example, the responsible director may personally clarify his directives and decisions. This represents the essence of a vertical processing of information in terms of communicability which is supplemented, however, by the similar horizontal processing. In such cases, members of collectives participate in discussing and clarifying information. As a result there occurs an "assimilation" of information by those to whom it is conveyed. Only then does it become a source of guidance to practical activities within the regulated subsystem.

It is the task of a subject of regulation to assure the greatest possible measure of communicability of information and hence, the greatest possible measure of its assimilation by those who carry it out. This is a necessary condition

for achieving a correspondence between the actions and activities of operational workers and the decisions of responsible directors (instructions, directives, rules, etc.). Naturally, the communicability of directive information is itself insufficient to produce adequate activities on the part of operational persons (regulation objects) in relation to decisions taken "above". A decisive role is played by the ability and readiness of operational persons to carry out decisions and by the availability to them of necessary means. If, however, decisions are developed on the basis of information that takes both the objective and subjective possibilities of operational processes into consideration, while the organizational basis for carrying out decisions is established in a rational way, if there is an operational regulation of the object's activities as well as accounting and control activities, then such decisions will be implemented, and an adequate correspondence will exist between the information contained in the decisions and the reporting information that is forwarded by operational personnel in the form of reports and surveys.

As the complexity and hierarchical dimensions of a system increase so do the obstacles to achieving a communicability of information and its assimilation by operational personnel, and so do possibilities of distortion and for a poor understanding of decisions. This is one of the reasons why the number of levels of regulation in administrative systems must be reduced. In short, regulation is essentially concerned with the development and execution of chains of decisions by regulating subsystems on the basis of information that reflects the state of the system and of its environment, as well as the intermediate and final outcomes of a system's functioning and information concerning the fulfillment (or non-fulfillment) of decisions.

Regulation is impossible without regulatory activities and without regulating commands that can only be formed by processing information concerning the manner in which earlier commands were carried out. It is only through information processing that the state of a system may be studied and evaluated at each moment in time and external and internal perturbing activities may be taken into consideration and assimilated or else neutralized.

Analyses, syntheses and generalizations of information concerning a given state of a system make it possible to identify trends in a system's movement and establish its future behavior, in short, to anticipate its future.

3. A MEANS OF SOCIAL REGULATION

Information constitutes an important means for the management of persons and of social collectives, i.e., as a means of social regulation.

The management of persons and social regulation refers above all to *defining* the social role of each person and his role in production, within the collective, i.e., his functions, rights and obligations. The role of a person within a socialist society depends on the needs of society itself, the nature of the collective to which he belongs and of the tasks that it is performing, of the level of training and personal characteristics, and on the abilities and interests of the individual concerned. Yet, this is only one side of the question. The other concerns the fact that society (a collective) defines the person's social role in terms of informational documents of a prescriptive normative character (laws and statutory instruments, charters, instructions, regulations).

It is also the task of the management to provide for an *assimilation* by each person of his own social role, his social functions, and rights and obligations, in order that he may view that role as his own personal responsibility. Otherwise individuals who perceive their roles in a formal manner will not contribute to their collective and to society all that they are able to give and will not utilize fully their abilities and possibilities. That problem is solved through education and training which acquire specific contents, forms, and methods within individual collectives.

The importance of social information in a person's assimilation of his social role is evident since that process is essentially a perception and assimilation of descriptive and normative information. It defines the parameters within which individuals act at their place of work and in everyday life, the alternatives for behavior, and degrees of freedom of choice of indicated alternatives, as well as the norms and rules on which they rely for guidance. As for the means

of assimilation (education and training) they are basically informational processes.

Finally, the management of individuals concerns each person's *possibility to fulfil* his social role. That problem is solved by society through legal regulation, controls and sanctions, systems of material and nonmaterial incentives, applications of methods of persuasion and education, and in the case of need, of coercion. The extent to which a person carries out his social role largely depends on his own view of the world, his ideological as well as professional training, the degree to which his actions are organized, and his capacity for discipline and responsibility. Here, too, the role of social information and especially of prescriptive and normative information is clearly important.

In organizing the process of informing individuals, subjects of regulation (the Party, state, central and local social organizations) disseminate social and particularly political information and develop a specific way of thinking and behavior among individuals that corresponds to the nature of socialism as well as to its interests and needs.

It is well established that it is not as a result of his biological nature that specifically human characteristics and social elements are acquired by man, but rather in the course of living and in the process of work and of living within a world that has been transformed by countless human generations. Yet man himself is not able to act in an isolated manner in a world that has embodied the highly diverse experiences of many generations. His relations to the world and to society are always mediated by his relations to other persons and by forms of relating to them, and exchanges of social information play an important role in these forms.

All this does not deny the role of inherited information and of anatomical and physiological as well as psychic traits received from immediate ancestors in the development of individuals. These traits contribute definite shades of difference to the process of a person's assimilation of social qualities and influence the development of his specific personality. In such a context, however, it is not they but social information assimilated from other persons in processed forms (from either current or preceding generations) or

else, acquired by the person himself as the result of his own experience, that play a decisive role.

The process that governs a person's development is a goal-oriented regulated process. This is particularly evident in socialist countries. During the initial stage of a personality's development it is carried out by a system of family and school education. Already then, a child or young person receives, aside from knowledge in the natural sciences, some social knowledge which gives him a conception of society, of the socialist order, of its principles, norms, and values and of the position of man within it. The qualities that mark a socialist personality are already being developed at that stage.

It is characteristic that the development of personality in the context of one's family and school is carried out through purely informational means, namely, through the conveying of information that has been primarily acquired by other persons. The child or young person himself is not yet able to participate in labor and in social activities and does not possess any social experience. His life experience is limited to the particular conditions within which he lives and studies.

Similarly, the education and training of individuals in centers of higher and of specialized education as well as in vocational and technical schools is also informational in character. The difference in such cases refers to the fact that in addition to "already processed" information, individuals receive communications, whose source is their participation in labor activities and in social life. Here again, the process of conveying information and of education is carried out in a purposeful manner in accordance with education plans and programs developed by the government. These take into consideration the needs of society and the level of development of science and technology and the current and long-term objectives that a given society confronts as well as other social factors.

At the stage in which the major role is played by families, schools, secondary schools and professional schools and universities, the development of individuals takes place primarily at a general social level. Individuals assimilate the view of the world, ideas, principles, norms, and values that are

characteristic of a socialist society, without relating them to specific levels (spheres of social life, specific collectives, etc.). They assimilate a general way of thought and of behavior. Their store of information consists of two polarized levels of information, first, concerning society as a whole, and secondly, concerning their immediate environment. A certain informational vacuum develops between these poles that will later be primarily filled through a process of active labor within a working collective.

It is true that during their training for a specific profession individuals are being prepared to enter into a labor collective, but the information they then receive does not include the elements of specificity and tangibility that alone are able to relate individuals to society and to help them clarify their roles in concrete forms at the level of working collectives, rather than in a relatively abstract overall social form.

It is well known that both a person's social role and his social qualities as a person on which the fulfilment of his social role largely depends are developed primarily under the influence of his social environment, namely, of production activities and of a particular system of social and moral relations. The general social environment constitutes the primary source of the information that is embodied in a person's individual characteristics. The influence of social information on individual persons, however, is mediated through a "microenvironment", that is, through his immediate environments within which a primary role is played by his labor collective.

"Microenvironments" constitute secondary translators of social information. And when they do not produce informational obstacles or "noise", in terms of cybernetic terminology, individuals assimilate the requirements of society and carry them out, embodying them into their own qualities, acts and behavior. Alternatively, they lead to the development of personality traits that do not conform to social ideals, i.e., of personalities who in varying degrees do not assimilate and do not carry out their social roles.

Whether a particular individual does embody the general social values, norms and requirements that he has assimilated in his specific activities within individual sectors of

socialist and communist development largely depends on information available at the level of socialist working collectives.

In socialist countries working collectives operating as sources of information are generally of enormous importance in the life and development of personalities. It is within such collectives that personalities express their labor and social activities and receive the means of livelihood and material and spiritual values that they require, as well as a social recognition of their work and a connection with society as a whole. It is within such working collectives that general social information and general social principles and values acquire a living embodiment and are tested and consolidated through the personal experience of individuals, which then constitutes the basis of a new system of communications, which this time relates to the specific collective. There is then that the process of personality development acquires a final form, as stable reference norms develop as well as a stable set of guiding rules.

It is at the level of socialist collective that individuals are informed about the position of the given collective within society, its objectives and tasks, its traditions, norms, and values, and about his own role within the collective and his functions, rights, and obligations. The collective informs the individual of his own present and future responsibilities, the system of payment for labor activities and of material and nonmaterial incentives that is employed within it, the nature of the individual's future prospects with regard to increasing his skills and his education, working and living conditions, and possibilities and prospects for socio-economic and spiritual development of the collective itself and of the individual.

In this way collectives lend concrete substance to social objectives and together with their own objectives translate them into objectives of individuals. They form the plans of individuals by orienting them towards a specific type of behavior, identify possible alternatives and methods and means for carrying out these plans, leaving a definite measure of freedom of choice to the individual.

The task of such a collective is to convey to each member his social role in such a way that he may assimilate it

effectively, and carry it out well, thus contributing to achievements of both the collective itself and of society.

In such a context, *prescriptive-normative information* serves as a powerful means of social regulation and as a means for assuring that each person and each collective carry out their social roles.

Prescriptive information contains the objectives that are to be attained by the particular social system in question. Above all, these objectives differ in content. Generally the major objectives confronting a society are economic, socio-political, scientific, technological, and ideological. Economic objectives constitute a basis for the entire range of general objectives, since the economy constitutes the foundation of social development. In class societies, objectives inevitably acquire a political color. It is precisely the political sphere and political objectives that operate as a major influence on all other objectives, penetrate them, and prevail over them. The corresponding priority of the political sphere over the economic one was noted by V. I. Lenin.

Objectives may also be distinguished in terms of the level of regulation to which they refer. Objectives of enterprises, production associations are one matter, while objectives of the economy and of society as a whole are another. There exists a hierarchy of objectives: within it the objectives of each lower level constitute subobjectives of higher levels. Each level also possesses, however, objectives that may not be reduced to objectives of higher level units.

In analyzing the objectives that are contained in prescriptive information it is important to take into consideration the time factor. Short-term and tactical objectives constitute the means for achieving long-term strategic objectives, even though each of them may also possess a relatively autonomous significance.

Objectives may be distinguished in terms of the form in which they are expressed. Strategic objectives are usually expressed in a qualitative form (for example, they may refer to further improvements in the regulation system) and appear as "trajectories". A trajectory represents a line of movement of a system along a path to the specified objective. There also exists a "point form" of expressing objectives, in which they are indicated as specific quantita-

tive characteristics whose attainment is projected over a specified period of time. In the case of strategic decisions the "point form" is expressed in terms of goal-oriented norms, while in tactical decisions it is expressed in terms of indicators that represent intermediate boundaries along the path to norms expressing goals. Such indicators are related to available resources. In terms of their sequence, they constitute a trajectory of movement towards the norms associated with objectives and the achievement of strategic goals.

Since the objectives that are contained in prescriptive information serve as an important guideline in the activity of collectives and of each individual person, they operate as a means of social regulation.

Normative information is quite close to prescriptive information and often coincides with it.

It represents a means for providing guidelines for the behavior of individuals or of social groups in specific situations as well as a means of control over their activities on the part of society. Because of these characteristics, social normative information operates as a regulator of social relations as well as of the behavior of individuals. It is mandatory in nature (in the sense that any violation of norms produces sanctions with regard to the violator), combines *prescriptive* and *evaluative communications*, and is embodied in corresponding documents (legal decisions, charters, etc.) or else into ideal forms (ethical norms, public opinion).¹

Laws represent normative acts possessing the highest legal power. At the level of the USSR itself laws are adopted by the USSR's Supreme Soviet, while at the level of individual Soviet republics, they are adopted by the Supreme Soviet of Union Republics, or else of Autonomous Republics. The Constitution, which is the basic law of the Soviet state, occupies a central position within the system of laws.

Within the system of laws there are codes that contain in a systematic form the basic legal norms that regulate

¹ Cf., Ye. M. Penkov, *Sotsialnye normy—regulatory povedeniya lichnosti. Nekotorye voprosy metodologii i teorii* (Social Norms as Regulators of Individual Behavior. Selected Issues in Methodology and Theory), Moscow, 1972.

specific spheres of social relations. While there are codes which apply to the Union as a whole most codes apply to Union Republics. They are based, however, on nationwide basic legal principles in particular problems (such as those expressed in the Fundamentals of Labour Legislation).

Decrees constitute still another type of normative acts. They complement individual laws and make them more precise and also change them. Decrees may be issued by the Presidium of the Supreme Soviet of the USSR and of Union Republics and are ratified by sessions of the Supreme Soviets.

A diversity of other normative documents represent statutory instruments and correspond to laws. These include resolutions and instructions of the Council of Ministers of the USSR, of the Councils of Ministers of Union Republics, orders, instructions and circulars of Union and Republican ministries and agencies and also of various central and local economic regulation bodies, and resolutions of local Soviets of People's Deputies and of their executive bodies.

Normative acts include orders, instructions and rules and regulations adopted by the executive bodies of enterprises, production associations, and organizations. These regulate the activities of the corresponding collectives in the economic sphere and in social life.

Similarly, technical, technological, and organizational norms (state standards and technical provisions) embodied in normative acts adopted by various organizations are also juridically mandatory.

Because they regulate the behavior of persons and of social collectives all normative acts are social in character. In socialist countries they are established by state bodies and their fulfilment is mandatory. They regulate the behavior of persons by assigning them specific powers as well as rights and obligations. In cases when specified normative acts are violated, their fulfilment is based on the state's power of coercion.

The most important characteristic of normative acts concerns their *informational* essence, that is, the prescriptive information that they contain and through which the state and its agencies express the will of the people, who is, in a socialist society, the sovereign subject of regulation. It is

precisely the support of information contained in normative acts by the power of the state that makes them a powerful instrument in the regulation of persons and of collectives and of all spheres of social life as well as of society as a whole.

The methods through which prescriptive information embodied in legal normative acts regulates particular relations, differ. In some cases the method of subordination is employed, in which one side specifies instructions to the other. The fulfilment of a state plan, for example, is mandatory for all levels of the economic organism. In other cases legal norms are accepted on the basis of a consent of both sides and acquire the form of a contract whose fulfilment is mandatory for both parties. On some occasions the method of recommendations is employed in which one side specifies recommendations to another about the best way of solving a problem. It is in this way, for example, that government agencies regulate the work of various cooperative organizations (collective farms, trade cooperatives, etc.).

Informational operations by regulation subjects on individuals and collectives through education, persuasion, appeals, and efforts to communicate a way of thinking and of behavior that corresponds to the interests of socialist society must be supported by practical activities that meet the material and cultural needs of individuals. Objects of regulation must know and must be convinced that the appeals, addresses, and demands are combined with corresponding rights and freedoms and possibilities for the comprehensive development of individuals. Regulation subjects must produce an interest on the part of regulation objects in the programs that are proposed, awaken their initiative and creative activities and provide the right of selecting specific means for achieving objectives.

It is only through a translation from a general language (at the level of society and collectives) to the specific language of each individual person and an awakening of interest towards needed useful information that it is possible to transform the social and collective objectives into the objectives of individuals and collective tasks into personal ones.

4. REQUIREMENTS THAT SHOULD BE MET BY SOCIAL INFORMATION

It has already been shown that the social information that is employed in the regulation of societies is quite diverse. There are certain requirements, however, that must be met by any type of such information, and it is only when they are met that information can serve as an effective instrument of regulation.

The very first of these calls for a class and Party objectives-oriented approach to the analysis and evaluation of social information. This expresses the direct connection of social information with policies and with the interests of the working class and of all workers and with the objectives and ideology of the Communist Party. Since socialism is a class society, it is natural that information concerning its functioning and development acquires a class character. A Party objectives-oriented and class-oriented approach to social information implies that it is utilized for the struggle of the working class, and of the working people against reactionary bourgeoisie and its ideology. This expresses itself most clearly in political information.

Only *systematized and complex* information meets the needs of effective regulation. This refers to information that combines various types of information and reports that are related both historically and logically and conveyed in a specific sequence. Such an approach makes it possible for the regulation subject to continually "scan" the social object that is being regulated in all its complexity and variety and to adjust its functioning and development in ways that are appropriate to each specific situation.

The need for a complex approach is especially relevant to the regulation of society as a whole and of large (territorial or else sectoral) subsystems within it.

Effective social information also requires a *correspondence between information and the competence and authority of the regulation subject employing it*. Competence in this sense refers to the set of functions, rights, and responsibilities of a regulating body or person. Information, however, is intended to provide for a rational implementation of

functions, the greatest possible realization of rights, and full responsibility for the decisions being taken.

Ultimately it is the directing person who is responsible for the functioning and development of a particular system, and it is he who is the principal user of information. It is therefore important to define the personal role of such persons in regulation and the list of issues on which they take decisions, since both the volume and content of information that they must receive depend on the nature of these issues.

In deciding at what particular level a specific decision should be taken it is necessary to consider at what level one will find the best conditions for obtaining the information that optimal decisions require. For the greater the distance of the level of decision making from the level at which the necessary information is easily obtained, the greater will be the possibilities for distorting that information and hence for taking erroneous decisions.

Thus a consideration of information factors is a prerequisite for defining correctly the authority and responsibilities of bodies and individuals engaged in regulation and for allocating the functions that they are asked to fulfil. In such a context, moreover, it is not authority that is allocated on the basis of information, but rather the reverse, i.e., information is allocated in accordance with functions.

One often meets situations in which a particular regulatory body requests from regulation objects information on issues that are far removed from its competence, while neglecting information that it does need. This produces situations in which it may appear that there is an abundance of information, and yet information needed for decisions is in fact missing. There are also situations of a different type, in which regulatory bodies possessing a specific limited authority collect a variety of information from subordinates even though decisions are taken on a specific issue. There is then an ambivalence in the interpretation of the issue and in the preparation and taking of the corresponding decision.

A clear definition of the sphere of competence and authority of regulating bodies and of individuals responsible for regulation, and a distribution of information in accordance with such distinctions contribute to an effective utilization of that information.

As the level at which a particular regulation system operates becomes higher the information that it utilizes is increasingly generalized. Detailed operational information is primarily employed by lower-level regulation bodies such as enterprises, administrative offices, and institutes. Middle-level bodies receive information that is partly generalized, and only the highest levels of regulation that take decisions concerning strategic tasks employ social information in its most generalized form.

A necessary requirement of information employed in regulation is that it be *full* and *optimal*. To provide for its optimality means that the regulation subject must receive that information which is necessary and sufficient for taking a correct decision and for effective regulatory activities.

An optimal amount of information contains the following: *all* necessary reports on all regulated parameters; *only* necessary reports; accurate and specific quantitative characteristics; and reliable, undistorted reports. It follows, that full information does not at all mean that absolutely all information concerning a system's environment is available, and that it reflects a situation with infinite accuracy. *Accuracy* refers to the extent to which information is detailed and approximates the original reality which it expresses.

In recording phenomena and processes of social life in the form of information it is fully permissible to admit shortcomings with regard to the fullness and accuracy of information. This is not surprising, since measures to increase the level of accuracy and of comprehensiveness of information call for increases in its quantity and diversity in ways that may produce serious economic sacrifices.

It might appear that when information is more comprehensive, more precise and more detailed the resulting decision will be better. There is a threshold, however, beyond which the expenditures associated with obtaining more detailed information become greater than the advantages derived from the improvement in decisions that they make possible. In providing information for regulation activities there is always a moment when more detailed and fuller information costs more than the absence of such information. This defines a specific problem, namely, to find the golden mean (this refers to the same optimum) that makes it

possible to increase the effectiveness of carrying out a decision in relation to the cost of expenditures on the corresponding information.

In such a context both studies and practical organization activities may be assisted by the methods of mathematical statistics and of probability theory. These make it possible to carry out the corresponding *sampling*, in order to study the selected objects, and then obtain through them information concerning the wider set of objects being studied and the system as a whole. The results of a sample are expressed mathematically in terms of a Gaussian curve. Its apex expresses the most typical properties of the given object, while its tails represent those which are not typical (extreme values). It is important to make certain that the sample is fully representative. For otherwise indicators that may be accepted as typical may in fact deviate substantially from average values, while contrasting characteristics will not provide the needed balancing.

Since the possibility of excessive economic expenditures defines limits to the fullness of information a need arises for defining discrete quanta, and for limiting the accuracy of description to levels that make it possible to solve particular tasks effectively. A quantum in such a sense is precisely the desired minimally acceptable quantity of information that is needed for solving a specific regulation problem.

More generally it should be recognized that all concepts of optimizing information possess a meaning only in the context of specific regulation problems, and that there does not exist an optimum measure of information generally. There can only be concrete optima that are associated with solutions to equally concrete problems of regulation.

To optimize information thus means to avoid both a deficiency of information and an excessive abundance. A shortage of information will not permit regulation subjects to form a correct conception of the state of affairs, understand the essence of the given problem, and take a rational decision. It operates as a source of subjectivism and of unjustified decisions taken too quickly. Similarly excessive volumes of information, too, are harmful, for it is then more difficult to systematize it. Much time and effort is devoted to its processing and there is a danger of "drowning" in flows

of unsystematized, unprocessed information. The result may then be the same as in the case of insufficient information, namely, unjustified decisions.

Yet excessively abundant information also possesses some advantages, and the corresponding literature therefore distinguishes between useless and useful abundance. For on the one hand an abundance of information reduces the measure of comprehensiveness and accuracy of information, and in such a sense it is useless. If, however, excessively abundant information makes it possible for persons to understand each other better, and to correct errors and distortions, then it is useful. A lack of excessive information produces large losses of information and distortions in the corresponding reports. This produces a need for a specific measure of redundancy within reports and for applying control codes in transmitting reports, i.e., for preserving a certain measure of excessive abundance. A striving to optimize information, however, calls for the greatest possible reduction of surplus information. This requires a better organization of channels and flows of information, an updating of the skills of persons receiving information (within regulating bodies at various levels), the creation of more generalized forms of information, and increases in its value and usefulness.

The accuracy of information is closely associated with its *reliability*, and with an objectively truthful reflection of the state of the object of regulation and of its environment. It is only when information is verified that it can serve as a reliable compass in regulation activities. Its reliability may be reduced by two types of causes. The first are subjective (the presence of a bias, subjectivism in preparing information, insufficient competence on the part of individuals working with information, etc.) and objective causes (perturbances in the transmission of information, failures of technical equipment, the impossibility of obtaining the needed information because of the insufficient development of science, etc.). To overcome these causes is an important task of regulation.

It should be noted that such characteristics of information as its comprehensiveness, its optimality, its novelty, and its usefulness are not absolute and autonomous. They serve

regulation only when they meet the criteria of *timeliness and relevance to operations*. Time is an enemy of information, and information ages over time. When information is not timely, it becomes useless, even if it otherwise possesses high qualitative characteristics (pertaining to reliability, comprehensiveness, accuracy, etc.) and is a cause of unjustified expenditures. Only information that is received, processed, and employed in time, that is, when a need for taking a decision arises, contributes to an optimization of regulation processes. A rapid shift of information flows to specific levels of the regulation system, to which it is addressed, overcomes a useless circulation of information.

In preparing for a decision and in taking a decision the problem of a *critical time* always exists. This refers to a boundary beyond which errors and failures in regulation will occur. This is a time beyond which it is either not possible to solve the problem at all, or else, if it is still possible, only with considerable losses.

The taking of decisions beyond their critical time is largely explained by difficulties in preparing information. The search for information and its processing and transmission to executive bodies are frequently delayed and this results in a postponement in the taking of decisions and in poorly timed decisions. The influence of insufficient time is especially felt in connection with the revolution in science and technology, which has increased the rhythm and rates of production and of all social life.

The meaning of timeliness is defined by concrete conditions and by the extent to which a problem has "matured." A premature collection and processing of information are useless since the problem has not matured, and subsequent inevitable changes in a situation make unnecessary the information that has already been collected. Similarly, the collection and processing of information that is too late result in a taking of untimely decisions, which frequently makes such decisions unnecessary and useless.

It should be noted that there exists an objective contradiction between comprehensiveness of information, on the one hand, and its timeliness and operational character. The fuller the information, the greater will be the efforts and expenditures of time that will be associated with its col-

lection, processing, and analysis. As a result the operational character of information is reduced and the process of preparing a decision is postponed.

To find the proper measure for sufficient comprehensiveness, on the one hand, and operational needs, on the other, is one of the difficult tasks confronting subjects of regulation and it is resolved in different ways. Among these the principal one concerns improvements in the information system, including its material and technical as well as its human components. This refers to the improvements of both the equipment and technology of information processing and in the professional training of corresponding persons.

That measure is flexible and depends on the character of the problems that are being solved and on the time that is available for solving them. When sufficient time exists, all possible information relating to the problem's solution is collected and analyzed. If, on the other hand, there is a shortage of time, it is necessary to accept a specific minimum of information and to base the taking of decisions on the experience and intuition of the responsible person. It is then also necessary to accept a definite measure of risk which derives from the insufficiency of information about the possible consequences of the decision.

Aside from a striving for the comprehensiveness and timeliness of information, considerations of *economizing* must also be taken into account in the sense of a need to reduce expenditures associated with collecting and processing information. Relations that exist between the comprehensiveness of information needed for regulating social processes and its timeliness and economizing aspects may be expressed in terms of a mathematical formulation.

Another requirement of information, particularly when it is expressed in the form of documents, concerns maintaining the *conciseness and logical characteristics* of informational communications while retaining a maximum measure of content. Conciseness increases the information density of communications, reduces the time required for the transmission and assimilation of information and economizes the corresponding means. Conciseness calls for an ability to concentrate the rich, diverse and complex content of sociopolitical events into wide-ranging arguments that are easily

followed. Naturally, the measure of conciseness depends on the nature of the information. It is one thing to communicate a fact or event. This must be extremely concise. And it is another to explain and analyze events. Here, reasoning, conclusions and proposals are needed.

A full perception of text information requires a logical exposition. It presupposes that the communications will be non-contradictory, consistent, and amenable to truth, as well as a proportionality between the space that is devoted to a particular question and the importance of that question. It also presupposes a clear conception of the objective that has to be achieved. Such a logical aspect presupposes that information is of a one-to-one character: it is characterized by unique correspondence within the framework of a given system, it must be able to preserve its contents, meaning and forms of expression in order that it may be understood by persons who employ it. This has led individual systems to apply methods of classification and to develop informational and terminological dictionaries.

Such a uniqueness of meanings calls for a rigorous discipline in thinking and expressing views on individual problems of social life, science, and technology. This makes it necessary to make more precise the contents of individual conceptions and terms and to unify them and identify them, and also exclude ambivalent interpretations as much as possible. It is not accidental that each field of information possesses its own thesaurus, i.e., a dictionary defining each word in a unique way. This serves to increase the quality of information and to avoid verbosity and multiple interpretations of particular words.

Information is expected to be *useful*, i.e., to contribute to the solution of problems that a system confronts. The usefulness of information is a concept that is close to that of the value of information. Since information reflects particular real phenomena and processes, it is always useful. As for its value, it is measured through the effect in regulation that is achieved with its help. Its value is always concrete and information is valuable in specific conditions and in connection with the solving of particular tasks or else a given class of problems. As the conditions governing the problems that are confronted by a system change, the value of

information dissipates. It is characteristic that indicators of the value of information change at different stages of the information process. At the stage of collection and receiving data value is determined by the number of signs: the smaller the number of signs that are employed in recording information, the more valuable it is. At the stage of processing, value is primarily determined by the meaning and content of information. At the stage of taking decisions, it is determined by the role of information in the preparation of regulatory activities.

It may occur that information is transmitted in a language (either natural or artificial) that is not understood by the user. It also happens that information cannot be understood because of its complexity and of the fact that the person to whom it is addressed is not able to understand it. Finally, it may happen that information that has been received is already known to the person to whom it is addressed, and once again, he does not receive any new communications. In all three cases, information turns out to possess no value.

An accumulation of new, valuable and useful information, together with a protection against accumulation of useless information, constitutes a necessary requirement for the rational organization of information processes.

CHAPTER VI

INFORMATION AND THE TAKING OF DECISIONS

The formulation and taking of decisions is one of the basic functions of regulation that serves as a comprehensive influence over the entire control process. It is not surprising that in its most general form, regulation is a process that encompasses the preparation and taking of decisions (including programs, directives, laws, plans, norms, instructions, designs) as well as their realization. To a large extent the effects of a system's functioning and its attainment of its objectives are predetermined by the quality of decisions, the extent to which they are scientifically grounded, and their relevance and timeliness. The quality of decisions, in turn, is largely determined by the comprehensiveness and reliability of the initial information.

1. REGULATION AND DECISIONS

A goal-oriented nature of control activities in the sense of a consciously directed movement of the system towards given objectives is an essential characteristic in managing social development.

A framework for man's and society's goal-oriented activities is established by prevailing social conditions, the nature of the given society, the economic relations that characterize it, and the nature of its socio-political structure. In contrast to capitalism, where the basic regulation forces are spontaneous, socialism makes a goal-oriented, conscious regulation at the level of overall society, as well as at all

other levels of the social organism both possible and necessary.

The formulation of objectives and the identification of tasks constitute regulation decisions of a specific type.

An objective should be directly related to available resources, to the established or the presumed principles for the organization of society and its elements, and to the social-psychological factors that make the attainment of the objective possible (the preparedness of people, the extent to which they are informed, their motivation, stimulation, ideals, and professional preparedness).

Decisions represent coagulated information that is specially gathered, analyzed and processed by the control subject. They are informational in their very essence. They rest on a synthesis that combines information defining the present state of the system with information concerning the future, and which is expressed in terms of an objective that is programmed and set before the system. This synthesis is reflected in the fact that decisions require two steps—observing and resolving. Observing relates to information about the state of the problem being solved and concerning the overall situation, while resolving contains prescriptive and normative information.

Aside from objectives decisions contain instructions for required sequences of actions along the path of movement towards specified objectives; sets of resources (material, financial, labor) and other means utilized in attaining objectives; lists of organizations and persons who are responsible for carrying out decisions; sets of rules that regulate the order of decision-taking, their entry into force, their implementation, changes and cancellation. As a rule, decisions possess the properties of a juridical act and are formalized in prescriptive administrative documents.

Decisions anticipate and predetermine the results of the movement of a system with some degree of accuracy because they represent programs and plans of a system's functioning and development. Decisions are prototypes of the future drawn by man on the basis of an analysis and evaluation of the present state of both the system and its environment. That result, objective is in turn the particular informational reason that "activates" all of the system's mechanisms,

and subordinates them to itself through its feedback loop. This interaction between objectives and the state of the system attained at each point in time serves as the signal that activates the regulating influence on the system which brings about its movement towards the specified objective. Regulation as a conscious activity directed towards the attainment of the given objective thus emerges both as an anticipation of practical influence on the system and as that influence itself.

The current tasks of socialist and communist construction and the revolution in science and technology deeply influence the process of formulating and taking decisions and set exceptionally high standards for them. As it leads to an ever increasing concentration of production that revolution creates highly complex social systems that integrate large numbers of persons, technology and materials. But as such systems become more complex, more comprehensive and more multi-dimensional, the number of decisions to be taken increases and these decisions become more difficult and more responsible. For the quality of component elements becomes more diverse while the number of linkages among them and communications with the environment increases. Thus the number of variables that control subjects must consider in making decisions increases, as does the number of internal and external influences that perturb the system whose neutralization or adaptation must be sought by the system's decision.

Since the function of a decision is to coordinate, harmonize and subordinate the functions of individual components and to coordinate internal and external relations and linkages it becomes natural that the more complex the system, the more difficult this will be to achieve. In particular it has been estimated that the difficulty of balancing economic linkages increases as the square of the number of elements in the national economy, while the difficulty of optimizing increases approximately as the cube of that number. This is because the volume and contents of the information that is necessary and sufficient for taking decisions increases in proportion to the number of possible alternatives.

At a time when a revolution is taking place in science and technology grandiose projects are being carried out through the joint efforts of large collectives of scientists, designers,

specialists and workers that require enormous expenditures of material, labor, and financial resources. In such a context even a minor error in a decision may cause large-scale losses and unjustified expenses. The accuracy of decisions and the extent to which they are justified influence substantially the rate of both progress in science and technology and progress in society as a whole.

The revolution in science and technology is also influencing deeply the entire system of social relations. Accordingly there is an urgent need for socialist society to take into account the *social consequences* of particular decisions in the sphere of production and science and technology. In deciding to construct a new enterprise, for example, it is necessary to consider the presence of available labor resources, housing and general community facilities. Similarly in bringing into operation new types of equipment or technology it is necessary to anticipate the need to train workers and specialists of the given qualifications. As production is mechanized or else automated it is important to determine beforehand where the people released from their previous place of work will be directed.

Decisions that are taken in a class society, whether they concern economic decisions or decisions relating to progress in science or technology or else social decisions proper inevitably acquire a *class orientation* and are ultimately taken in the interest of that society's ruling class. In a contemporary capitalist society, for example, one does find a definite orientation of science and technology on persons, but that orientation is attributable to well-defined class-oriented causes.

In particular a capitalist cannot separate the laboring person from knowledge, since if he were to do this he would not be able to utilize contemporary science and technology whose applications capitalists require in order to survive in an intensely competitive struggle. Yet capitalism seeks to educate the laboring person in such a way and to provide him with a such system of knowledge that his thoughts, acts and behavior are placed within the framework of the basic principles that govern a society based on private ownership, and to make him a fellow participant in the "common" cause of the firm, association, or society as

a whole. And that "common" cause is the profit that is received as a result of exploitation. Within such a framework neither the real needs of the personality nor of society are actually taken into account.

Decisions taken in a socialist society, on the other hand, are another matter. Their ultimate objective and aim is the *people's welfare* and the fullest possible satisfaction of the material and spiritual needs of working people.

The Communist Party and the Soviet state have no greater responsibility than the one for the welfare of the people and the satisfaction of the material and spiritual needs of the working people. This is fully confirmed by the decisions of the CPSU's 25th Congress concerning economic, political, and social issues. These clearly reflect a striving to make the lives of the Soviet people still more secure and happy.

The principal task of the regulation subject, that is of a body or else a responsible person taking decisions, is to take into account available resources and known external as well as internal constraints in an optimal manner. For a specific social system within the framework of society such as an enterprise, for example, external constraints refer to legislation possibilities and the behavior of suppliers and consumers, while internal constraints include participating organizations and the socio-psychological climate within individual collectives.

Strictly speaking, it is not possible to arrive at an absolutely optimal decision in relation to a social system in which the number of variables is infinitely large. For it is then not possible to identify and analyze in detail all of the possible alternatives. Nor is it possible to forecast with full accuracy, and even less to take all possible perturbing influences into account. In such cases the objective of decision-taking is to identify and study those alternatives that have the greatest probability of leading to the desired objective with given means, and that the study of these alternatives does take into account the greatest possible set of perturbing influences.

It is by constraining a criterion of optimality that the difficulties of optimization are usually met. The resulting decision is then optimal in a relative, rather than an absolute sense, i.e., in relation to the selected criterion of

optimality. That criterion, however, is not the result of subjective wishes on the part of the regulation subject, but rather of a comparison of objectives with available means. The greater the extent to which a process may be expressed quantitatively, the greater is the measure to which optimization is possible. Once the process being optimized is expressed in quantitative terms its optimization may be achieved through mathematical decision theory.

A large number of methods of optimization have been described and applied. As a rule, they are designed to refer to technical, technological, and economic problems. A solution is usually seen as optimal when an objective function is maximized or else minimized. In such a context the possibility of achieving minimal deviations from the objectives under a diversity of possible circumstances is established through forecasting the consequences of the decisions being taken.

Usually an optimization of decisions is interpreted as an exclusively economic optimization. In such cases those decisions are viewed as optimal (in the most general sense of that word) that make it possible to achieve the objective in the shortest time possible, or else, with the least possible expenditures. Additional indicators that lend themselves to a quantitative representation may also be employed as criteria. These include productivity, repayment time, and profitability. Occasionally decision-makers connect an optimal decision with full and accurate information, forgetting that excessively abundant and detailed information results in important economic losses and expenditures of time that ultimately reduce the effectiveness and optimality of decisions.

While economic criteria of optimality are unquestionably important they are not sufficient in relation to social systems. For in such cases it is human factors that are the most important ones, and these do not conform to the economic criteria. Work is currently proceeding on noneconomic criteria that are intended to encompass both the short-term and long-term consequences of economic decisions in the social and spiritual spheres of social life.

In socialist countries decisions must take into account not merely economic, technical and technological aspects, but

above all the human aspects that are expressed in political, social, moral, psychological, and other forms. The preparation and taking of decisions in socialist society constitutes a process that is *primarily guided by the needs of man*.

A decision that is optimal in the most general sense of that word is one that contributes to the further consolidation, improvement and development of a socialist society and to its successful progress on its path to communism and contributes to the comprehensive development of man.

There exist two basic methods of decision-taking, namely, individual or personal decisions and group or collective decisions. In the first case they are taken by the directing person himself, who then assumes full responsibility. Such a person may rely on the knowledge and experience of subordinates and always does make use of them in preparatory work with information. In the second case decisions are taken collectively on the basis of relevant information that is available to participants. Both methods possess advantages. The first encourages responsibility on the part of directing persons for the decisions that they take. The second increases the probability of an effective implementation of decisions by making them common to all participants in a group. Which method is best in a particular situation depends on the nature of the problems being solved.

Lenin supported an organic combination of individual decisions with group decisions. Individual responsibility and individual management "are as necessary as collectivism is essential in discussing basic questions if there is to be no red tape and no opportunity to evade responsibility".¹

At the same time Lenin cautioned against an overemphasis on group decisions, that transforms group institutions into lecture halls, and against the type of irresponsibility that takes cover behind group decisions. "Collegiate methods", he said, "must not exceed an absolutely indispensable minimum", emphasizing that the final decision should belong to one manager, "to one comrade, known for his firmness, resolution, boldness and ability to conduct practical affairs and who enjoys the greatest confidence".² In all cases group

¹ V. I. Lenin, *Collected Works*, Vol. 30, p. 245.

² *Ibid.*, Vol. 29, p. 437.

decisions should be combined with a rigorous definition of personal responsibilities on the part of managers. But at the same time Lenin was not tolerant towards the misuse of power, and disregard for the opinion of collectives. He asked for the accountability of managers to those collectives in whose name decisions were taken, and to the masses who were called upon to carry them out.

A method that is very fruitful in preparing and taking decisions is *systems analysis*.¹ Above all, this requires an identification of the objectives of society or else, of its individual subunits within a given time horizon. The importance of each objective and its position within a system of other objectives is then evaluated, as is the extent to which they either agree or conflict with each other. The objectives that are identified are subdivided into subobjectives, i.e., into more concrete objectives bearing on the development of the economy, of culture, and on other spheres of social life which serve the achieving of general objectives. These tasks are then studied and evaluated in order to define ways and means for solving them and hence, for achieving the specified goals.

Systems analysis makes it possible to study changes in one part of a system jointly with changes in other parts, as well as to identify alternatives that depend on expected events and select those among them that correspond to a specific situation. When systems analysis is applied regulation subjects acquire more or less operational decisions for different problem situations that may arise in the future. This does not mean, of course, that these decisions may fit all possible cases. Social life is exceptionally unpredictable and the probability that unexpected situations may develop is substantial. A regulation subject who does possess alternative solutions, however, is largely freed from the need to take rapid and subjective decisions and from the major errors and failures that this may bring.

Systems analysis is essentially a method for bringing order into a problem through identifying a system's ob-

¹ Cf., S. L. Optner, *Systems Analysis for Business and Industrial Problem Solving*, Englewood Cliffs, 1965, and D. J. Cleland, W. R. King, *Systems Analysis and Project Management*, New York-London, 1968.

jectives, constructing a tree of objectives, identifying alternatives for achieving them, and elements of interdependence within the system in the course of carrying out these alternatives. It also defines the set of problems being solved and identifies the constraints that derive from both within the system and its environment.

When applied to decisions that are highly complex this method presupposes a reliance on the principle of divisibility which is simply the heuristic principle of reducing complex problems to a set of simpler ones. In such a context the applicability of the principle of the divisibility of information is determined by the divisibility of the system itself into an hierarchical series of subsystems to the level of those elementary subsystems that continue to retain the qualitative properties of the system. A solution of problems at the level of such elementary systems reduces, when synthesized, to a solution of the problems confronting the subsystem at the next higher level. Gradually that process becomes more complex and is ultimately integrated in solutions bearing on the overall system.

2. THE INFORMATION BASIS OF DECISIONS

Essentially the process of formulating and taking decisions is an information process. As an information document a decision represents the outcome of complex work with information. The corresponding process includes the following sequence of stages:

- definition of the task (objective);
- definition of the quantity and quality of information needed for taking a decision;
- the collection and processing (systematization) of information;
- the creation of information models;
- the identification of alternative decisions for the problem and for achieving specified objectives;
- the selection of a criterion for evaluating alternatives;
- the evaluation of alternatives;
- the selection of one of the alternatives and the taking of the corresponding decisions;

adjustments in the decision in the course of its implementation.

Usually these stages are aggregated. In particular, H. Simon¹ identifies only three stages (a search for the problem, a search for possible solutions, and the selection of a decision among alternatives), while Ye. Z. Maiminas, identifies four (the preparation and analysis of information, the identification of the task, the elaboration of alternatives, and the taking of a decision).²

Yet no matter how many stages are identified, the initial step in preparing for a decision concerns the collection and preparation of information concerning the internal state of the system and of its environment. Subsequently information is processed, and on that basis, the existing situation is defined. The situation is then compared to the general objective confronting the system, and divergences between the situation and the objective make it possible to formulate the problem to be solved.

In practical operations concerned with regulation there are, of course, many situations in which available information serves as a direct source and as a basis for the taking of decisions. Yet such a direct relation usually exists only in cases when the decision itself follows directly from information and is suggested by it. This refers to decisions taken in relation to simple systems. In the case of decisions taken in relation to relatively complex multifactor systems,—and social systems belong to such a category—information and decisions are mediated by a *special analysis* (economic, social, socio-political, ideological) that depends on the nature of the system and of the decision being taken. The purpose of that analysis is to derive from various types of data that are frequently unrelated and which reflect individual phenomena and facts a general integrated image of the process, and to identify the laws of behavior and trends that characterize it. Such an analysis produces grounds for a decision.

In such a context the importance of economic analysis of activities of enterprises, sectors, and production associations,

¹ H. Simon, *The Shape of Automation for Men and Management*, N. Y.-London, 1965, p. 54.

² Cf., Ye. Z. Maiminas, *Protsesyy planirovaniya v ekonomike*, (Planning Processes in Economics), Moscow, 1971, pp. 180-86.

is very considerable. It makes it possible to identify and mobilize internal economic reserves and to produce an integrated image of the economic state of a particular object and of all relevant positive and negative factors. Such an analysis serves to increase the production efficiency.

At the level of enterprises, organizations, production shops and production subdivisions the analysis that is carried out is primarily operational and is associated with the needs of operational production management. Its task is to receive and generalize information about deviations from the planned course of production, to evaluate their possible consequences, and to find ways for overcoming deviations or warning about them.

Analyses of current situations serve short-term planning, while long-term analysis serves the objectives of long-term planning. In the first case short-term trends are identified as well as corresponding factors, while in the second, there is a concern with fundamental trends and long-term factors. Long-term analysis is based on short-term analysis and merges with forecasting.

Finally, there are applications of general theoretical analysis, which approaches all types of analysis in terms of the principles of Marxist economic theory.

Economic analysis is intimately associated with socio-political analysis, since, as has already been noted, the economy is closely linked to the political sphere and to social relations. It is the task of socio-political analysis to study and find ways for increasing the social effectiveness of the socialist social system, and of its component subsystems at various levels.

In such analyses a system of criteria is employed together with a system of indicators that makes it possible to evaluate the effectiveness with which a particular object functions and to identify problem situations.

Next, once the problem situation has been identified, the problem itself is defined. The technological scheme representing the process of decision-taking is applied at this stage, the structure of the problem situation is identified, factors and relations are quantified, criteria and conditions for solving the problem are defined and compared, and the mutual consistency and evaluation of the problem's com-

ponents is established. In short, an analysis of the problem situation is carried out at that stage, and a model of its solution is developed.

Because the factors that perturb the system are not unique in their character and are stochastic in nature different ways may exist for solving problem situations.

This makes it necessary to identify alternatives. The operations that lead to this include the development of models, and procedures, including solution algorithms, the formulation of alternatives proper and their comparison, and forecasts and estimates of feasibility of individual alternatives as well as of their possible consequences.

The very taking of a decision, which is the concluding process in the sequence, presupposes a clarification of the selection criteria of models of alternatives (the identification and ranking of specific criteria, or else, of preference rules, the process of selection, in accordance with adopted criteria, the application of the ordered system of criteria to an ordered sequence of alternatives) as well as the embodiment of the resulting decision in a specific documentary form that is then transmitted to persons executing it.

Within such a range of decisions there are two extreme types, namely, fully programmed decisions and non-programmed decisions.

Programmed decisions refer to solutions of well-structured, standard problems that are frequently encountered and that recur periodically. The development of infrastructures for the taking of fully programmed decisions is the ideal of automated regulating systems. That ideal, however, is not attainable in practice, since decisions in the sphere of social regulation are associated with an extremely large number of factors and constraints that cannot be fully taken into account, and to an even lesser extent, formalized.

In the actual practice of regulation *nonprogrammed* decisions prevail, and in such a context, programming is applied only to the solution of specific subprograms. Decisions are then taken by directing persons or regulation bodies on the basis of the information that they receive.

From the point of view of the availability of information, decisions are taken under the following conditions: certainty or else uncertainty with regard to risk.

Conditions of certainty exist when the decision-taking subject possesses necessary and sufficient information concerning a system's state and its environment, or else, when there already exists a body of experience with regard to the solution of a given type of problem. In short, under conditions of certainty comprehensive information is available to describe a standard situation that defines a similarly standard and unique solution leading to a fully defined outcome. Precise, quantitative methods may then be applied that makes it possible to take optimal decisions in accordance with accepted criteria. Decisions of this type are taken more often in the regulation of technological processes, and also of certain economic processes, and less frequently in the organizational regulation that is associated with the activities and behavior of persons. But such conditions are not met in the case of socio-political and ideological decisions.

More generally it should be said that full and absolutely certain information cannot exist in the preparation and taking of decisions regarding social systems. Social processes are so mobile and the relevant situations change so rapidly that no information can give comprehensive knowledge about a particular situation and no past experience is able to identify solutions for new problems.

Instead it is conditions of *uncertainty* that are typical of social regulation. A system's state, or else the state of its environment, is either not known or insufficiently known.

Since the extent of information services for a decision may range from a nearly total lack of information to comprehensive information, the corresponding range of uncertainty may vary from a unique possibility to a practically infinite number of alternatives. A lack of information may be partly compensated by the directing person's knowledge and intuition, and his experience in solving similar problems.

Decisions are also taken under conditions of *risk*, in which a priori (probabilistic) characteristics of the system and of its environment are taken into account.

This, too, is in effect carried out under conditions of uncertainty. Yet even a relative adequacy of information about the system's state does not make it possible to verify all available alternatives. Those alternatives that have been

identified, moreover, are not sufficiently reliable to permit the taking of decisions without producing negative consequences. Generally available information does produce signals concerning possible negative consequences but does not indicate how they may be avoided. Under conditions of risk each regulating activity may produce a variety of outcomes, each of which is itself stochastic.

Such situations are typical in the management of production activities, in internal political decisions, and especially in external political decisions, in which the final outcome is influenced by a large number of factors that cannot be all taken into account with sufficient accuracy.

Solutions to some types of problems characterized by risk may be assisted by applications of probability theory, of analytical procedures, of so-called decision matrices and of mathematical models. Nevertheless the principal element in taking decisions is the personal experience, knowledge, and intuition of the responsible person.

A few additional comments on the relation of information to intuition. At first it may seem that these conceptions are incompatible with each other, particularly in relation to regulation activities and the taking of decisions. Information refers to communications that describe the state of an object and of its environment. As information becomes more comprehensive and more organized the need for intuition is reduced. Yet intuition is not possible without some information, since intuition is not a mystical and otherworldly phenomenon but a feeling and a way of thinking, in short, a sensing that is primarily based on the knowledge and experience of a responsible person, his overall perspective, and the general extent to which he is informed. It is true that this refers not to knowledge and not to information on the basis of which a concrete problem may be solved, but rather, to information that has been accumulated in the course of learning and practical activities. It is this that produces the intuition that is so vital to responsible persons in taking decisions in situations of uncertainty and of risk.

The role of intuition is especially important under conditions of severe time constraints and when the regulating body, the responsible person finds it necessary to take urgent decisions without access to sufficient information.

It should be emphasized that no matter how optimal information may be, taken by itself it will not produce effective decisions. The quality of decisions is influenced by subjective and emotional factors, and above all, by the regulation subject's evaluation of the information that is employed in formulation and taking of a decision. It is therefore natural that an ability to work with information and a competence in evaluating it and applying it contributes to the quality of decisions. Yet it should be taken into account, that decisions are frequently taken in extremely complex situations, when there is insufficient time, and that this influences them in a negative manner. In such cases, the primary information is not always evaluated competently. There are also subjective factors that operate as negative influences on the evaluation of information and hence on the quality of decisions.¹

But even in situations favorable for taking decisions evaluations of available information and hence the quality of decisions may also be influenced adversely by personal characteristics of the responsible person. In some cases there may be a tendency to find shortcomings even though they may not exist. This results in a failure to recognize problems where they do exist and in a tendency to underestimate the importance of the work of others. There are also cases in which the actual state of affairs is replaced by a tendency to confuse reality with what one wishes to see. This produces a lack of attentiveness to problems that have not yet been solved and to existing difficulties and contradictions, as well as an unfounded optimism and a tendency to mislead oneself. Similarly the quality of decisions may be influenced by the tendency of individual responsible persons to insure themselves against possible risks. This results in a failure to recognize actual possibilities or reserves or else a tendency to ignore them. Similarly selfish motivations and an orientation on one's personal career may lead to contradictions between the interests of collectives and of society, on the one hand, and those of persons taking decisions, on the other.

¹ Cf., G. Pospelov, *Glavny factor upravleniya* (The Principal Factor in Regulation), *Nauka i Zhizn*, 1970, No. 6, p. 6.

Half-hearted decisions may produce the appearance that measures have been taken and that particular activities are being carried out, while, in fact, these do not bring about a solution to the problem.

Subjective factors that produce adverse influences on decisions may be overcome by improving the ideological and political as well as the professional education of responsible persons, by increasing their sense of responsibility for the tasks that have been entrusted to them, and by improving supervision and inspection, especially by the Party, over administrative activities.

Knowledge derived from various fields of science and technology and practical experience are used widely in enhancing the role of experts and of expert information in regulation processes and in the formulation of decisions.

Sources of expert information include specialists who possess an intimate knowledge of the area to which a decision is to be applied, who are familiar with scientific methods for the study of such areas. Expert knowledge is needed for the analysis, planning, forecasting of the development of complex systems in which qualitative characteristics prevail, in order to determine the quantity and quality of information that is necessary in order to take a decision, as well as to identify, evaluate and select alternatives.

In such a context the services of experts from outside the given organization are particularly important. This is because they are not associated administratively with the given regulation body or with the responsible persons taking decisions and because they are able to prepare and evaluate decisions and to anticipate their outcome and consequences in an unbiased manner.

Experts channel scientific and technical information directly into production and into social life. They make it possible to combine the knowledge of different types of specialists and to produce complex information. In situations marked by exceptional complexity and by intensity in production and in social life as well as by a rapid progress of science and technology, no responsible person, even of the highest authority, is able to take competent decisions in relation to the numerous issues that continually arise. It is only by

leaning on specialists and on experts that they may be able to meet the requirements of our times and of the revolution in science and technology.

The problem of providing information for the regulation process includes providing information concerning decisions that have already been taken. Under socialism this refers to informing not only executives, but also the working people themselves to whom a large number of decisions is directly addressed. Other decisions, moreover, may also presuppose the active participation of working people in their execution, even though they may not be addressed to them directly. It is therefore natural that a comprehensive familiarization of both executives and workers as well as members of society generally constitutes a prerequisite for carrying out decisions.

The process of informing others about decisions requires considerable expository, ideological and organizational work and informing public opinion about decisions and the outcome of their implementation. In addition different regulating bodies exchange information concerning the decisions that they take.

A relatively well-structured system has developed in the Soviet Union for conveying information about decisions that have been taken. Both central and local regulation bodies possess specialized units (general and protocol divisions, administrative departments, secretariats, etc.) that are responsible for such activities.

These activities are less well-developed at the level of individual agencies, however, where corresponding centralized offices may not yet exist. Much time is expended on the retyping, duplicating and communication of decisions, especially when the level of regulation immediately below the highest one is engaged in communicating such decisions to lower levels of management.

Most decisions are communicated to executives and to the public through official channels. Original texts of decisions are published in special issues of publications of the regulating bodies, for example, in *Vedomosti Verkhovnogo Sovieta SSSR* (Bulletin of the Supreme Soviet of the USSR), or else, in other publications, including newspapers, journals and bulletins. In this way decisions become known to in-

interested persons and organizations and to members of society at large.

An oral informing and explanation of decisions taken by the Party, Soviet and economic bodies is also widely used. This includes not only activities in communicating information but also political and organizational activities among the population whose purpose is to bring about the implementation of decisions. Explanations are then provided not only of the decisions themselves, but also of their political and ideological meaning, while the development of a public opinion concerning particular decisions as well as a social evaluation of its importance are encouraged. Work of this type is carried out at different meetings, conferences, meetings of activists, at enterprises, collective farms, state farms, organizations, and places of residence.

3. PROBLEM SITUATIONS AND DECISIONS

Decisions are caused by *problem situations*, that is, by situations in which the existence of a particular state of the system produces a need for another state, because the continuation of the current state interferes with its normal functioning, improvement and development.

The scope and contents of such problems, their intensity, concrete forms and methods for solving them will differ for social systems that have reached different levels of social organization. The higher the level obtained by that system along the ladder of social organization and the more it is complex, the greater will be the volume and diversity of problem situations and the greater will be the importance and responsibility attaching to decisions.

To solve the problem, it is, above all, necessary to identify it, to correctly understand its importance, and to formulate it clearly. A great variety of regulation problems may arise. Some of them are self-evident, while others are still emerging and may not be apparent. In such cases, their identification, evaluation, and solution may require considerable research efforts.

The following are symptoms indicating the existence or emergence of a problem:

when the functioning of a system at a particular specific time does not meet specified objectives;

when a presumption arises that the system's functioning will cease to meet objectives in the near future;

when there arises a need for changing established objectives.

It is important to arrive at a correct *formulation and evaluation* of a problem. The first of these requires an ability to identify a system's actual and desired states, problem elements and constraints on problem solutions, as well as the criteria that a solution must meet.

As for the evaluation of a problem this relates to the need and possibility of its solution and to ways and means for achieving solutions as well as to consequences of solutions.

Problem situations may be divided somewhat arbitrarily into two large classes. The first of these relates to "new problem" situations, in which a problem emerges that does not have sufficient precedents in the functioning of the given regulation subject and of the given system. The second class refers to situations in which "new possibilities for solving known problems" appear, when current methods for solving them become obsolete or else insufficiently effective and more effective possibilities for solutions appear.

Naturally standard types of problem situations also emerge in the functioning and development of the most varied systems. But this does not imply that such problems call for similar solutions in the case of different objects. In particular, social systems are so specific in nature and so distinct from each other, especially with regard to their human components, that a rigorous consideration of the specific characteristics of each concrete system is a necessary and very important condition for solving any problem of regulation.

In the regulation of social systems one often meets situations in which objective reality itself as well as practice produce a problem situation. In such cases contradictions and difficulties have reached such a point and have attracted the attentions of individuals to such an extent that they have become apparent and visible. An information search does not then constitute a major problem. Information

bearing directly on facts, contradictions and difficulties is then required. The negative consequences of the problem are usually evident and accordingly there is no need for special forecasting information.

But possibilities for taking optimal decisions are then usually quite limited. This is because the causes of difficulties and conflicts have either been insufficiently studied or else not studied at all, either because available time for taking a decision is limited, or occasionally because the time and possibility for choice have passed. A decisive role is then played by past experience and familiarity with similar situations as well as by the intuition of responsible persons and their capacity to accept an appropriate measure of risk.

Such critical situations cannot be excluded. But it is the task of regulation subjects to avoid them. Above all this may be achieved through an effectively organized information system, particularly with regard to feedback information, which sometimes makes it possible to foresee the development of a system within a given time interval on the basis of seemingly insignificant symptoms.

The smaller the number of critical situations, and the more regulation activities are systematized and thought through, the greater will be the regulation system's effectiveness.

There is a second and more effective way for preparing and taking decisions, namely, through a forecasting of problems or rather a planned search for emerging problems. The art of regulation consists not merely in successfully solving visible problems, but also in anticipating emerging problems and in being prepared to resolve them effectively in time. The difficulties, contradictions and bottlenecks are then not yet clearly visible and there are only individual symptoms, frequently not very apparent, that indicate the possibility of their emergence in the future. Already then, however, a serious information search must be carried out as well as an attentive study of different, and occasionally seemingly insignificant aspects of a system's functioning in order to identify prevailing trends as a basis for anticipating the course of a system's development.

A capacity for a comprehensive preparation for decisions is then developed. The current state of a system is taken

into account and probable courses of development and problem situations suggest different variants of solutions which are then studied and evaluated in order to establish the possibility of applying them in different possible situations. In this way regulation acquires a systematic and, what is especially important, a flexible character. The regulation subject acquires a set and reserve of possible strategic decisions, and in view of the extreme mobility of social reality, this is very important. The planning of internal social measures and of external political measures is a necessary trait of the scientific regulation of a socialist society.

As the range of possible strategic decisions is widened the measure of optimality that a regulation subject may achieve in his forecasts increases, as does the extent to which he is able to carefully work out decisions and consider their social implications. The essence of optimal programming lies in an algorithmization of the process through which preliminary studies of variants are carried out as the best or optimal among them is sought.

Forecasting information possesses a direct regulation function as well.

A forecast of the future of a particular social system influences persons who are currently engaged in carrying out the forecast, since it affects their interests. Whenever forecasts correspond to the interests and needs of persons, they contribute to their own realization and when they do not, they interfere with such realization in a variety of ways.

In their role as ideal objectives in thought, models of the future exert an enormous influence on the current thoughts, activities, and acts of persons at present. Because they are based on calculations concerning specific types of behavior on the part of particular persons and classes they also possess an important significance in terms of propaganda.

The influence of forecasting information on regulation may be employed for achieving different objectives. This depends on class and society in the interests of which forecasts are prepared and carried out.

Regulating decisions are thus always solutions of problem situations. But what is then the basis of a system's capacity for meeting problem situations?

If one considers this question from an informational point

of view the answer will then be that it depends above all on the *system's informational state*. This refers above all to the following two aspects. First, the extent to which the subject of regulation is informed. This includes both the possession of experience in solving problem situations and the availability of necessary and sufficient information concerning the system's state and its external directions within each given segment of time. Second, the degree of organization of a system, in a sense that refers to a state of being informed (the opposite of entropy and of disorganization) and also to the system's capacity to restructure itself in such a way that following its assimilation or neutralization of perturbing actions it may not only preserve its qualitatively specific characteristics and its normal functioning but also perfect itself and develop.

Naturally, any social system that has functioned for any length of time, possesses a reserve of information. Such a reserve constitutes a crystallization, as it were, of the experience in matters of both the internal organization and interaction with its environment that the system has acquired during its existence. It is on the basis of that experience that a given structure has developed, together with a particular set of interactions among the system's internal components, a specific type of internal integrity and qualitative specificity, and a similarly integrated type of interaction between the system and its environment. The system's structure thus embodies information that reproduces its own history, as well as the structure of factors in the external environment that operate on the system in the course of its historical development.

Since social systems possess a definite accumulation of information that they acquire through past experience they are freed from the need to coordinate the functions of their components in new ways, as well as to similarly coordinate their interactions with their environment under those conditions in which the system developed and operates. The essential feature of a system's movement then concerns the transformation of information received from its own experience into a network of internal and external links that provide for its functioning and development and for the utilization of its information in continually solving new

problem situations. Thus means for solving specific problem situations, namely, those that are already programmed through past experience are in fact embedded within the system itself and its experience which is accumulated in a reserve of information. Highly organized (highly informed) systems that have already experienced a complex and many-sided development naturally possess a larger volume and diversity of information and hence wider possibilities for overcoming problem situations that arise than do systems that are less organized.

It is important to emphasize that "old" historically acquired reserves of information serve as the basis for improving and harmonizing a system's internal state as well as its external communications. Systems perceive changes in both their internal and external environments in the form of flows of additional information that adds to their past experience and perfects their internal structure and their interactions with their environment in terms of their ability to overcome problem situations.

In this way an accumulation of information and a growth in its volume as well as a diversification of its content occur as a result of a system's functioning and development on the basis of its growing experience in solving problem situations. The store of information that a system possesses acquires additional records of internal and external interactions. And more information accumulates as a greater measure of interaction follows both within the system and externally.

Not all information received by the system is then accumulated. Rather it is only that part of it which was the outcome of a solution to the problem that was important for the system's viability.

When a system's internal and external conditions are sufficiently homogeneous and stable a type of informational stagnation occurs. The system's functioning then becomes partly automatic since available reserves of information are sufficient to meet existing perturbances. In short there do not arise any problems in the strict sense of that term.

Such a "problemless" functioning, however, is only an abstraction, since social systems are unusually mobile, multi-dimensional and contradictory. In such a context, per-

turbances are continuous and problem situations continually arise, together with a continuous need for regulation in order to meet these problems.

Regulating decisions are statistical in nature. Rather than being uniquely determined by the system's internal and external environment, they are usually outcomes of selection, following a comparison of different alternatives, adjustments, and a development of those alternatives that correspond most adequately to the system's needs. A decision constitutes a reaction to a complex set of different influences that are individually random in character, and naturally, such a randomness among perturbances inevitably produces an element of randomness in corresponding decisions. Because of this random element, decisions and regulating activities that are activated by external and internal perturbances may differ, just as resulting changes within the system may also differ. The usefulness of such changes as well as their right to prevail is ultimately determined by practice and the correspondence of outcomes with the objectives that a given system confronts. As a result, the capacity of a system for solving problem situations and for regulation is improved and developed.

The process through which information accumulates, is ultimately determined by a system's historical experience. Yet that process is also indeterminate, random, since decisions of problem situations are of a random character, and this produces an increasing diversity of information.

4. DECISIONS AS INFORMATION MODELS OF PROBLEM SITUATIONS

The regulation and the solution of problem situations may call for the creation of mobile information models within regulating subsystems (subjects of regulation).

As models of problem situations decisions arise when the situations diverge from past experience and when available reserves of information are insufficient to undertake adequate responses. In such cases problem situations inevitably arise, together with corresponding models, that is, decisions. The intensity of such problems, moreover, depends on the extent

to which a given situation diverges from the system's past experience. As that divergence increases so does the intensity of the problem. The corresponding information structures of decision models therefore differ, and this is expressed in different proportions between information acquired in the course of experience and information pertaining to the specific problem situation itself. As this particular divergence increases, so does the proportion of information about the given situation, while the proportion of information acquired in the past is correspondingly reduced. Extreme cases may arise in which a given problem situation differs completely from past experience. In such cases decision models are developed exclusively on the basis of information concerning the current situation, since the mobilization of past experience recorded in information is, in fact, unable to help the system in solving the problem.

Each regulating operation represents a means for solving a particular problem or at least an attempt to solve it. Naturally, regulating operations that are useful and correspond to the specific objectives that a given system pursues cannot be carried out if the regulation subject has not developed corresponding prerequisites in the form of a model that anticipates the future. Such models contain not only a program of regulating operations but of anticipated outcomes as well. It is not rigid in character but rather dynamic, since the system encounters dynamic situations which cannot be anticipated in all their practical details. Accordingly the regulation subject finds it necessary to continuously carry out probabilistic forecasts and to select those activities that are most appropriate to particular situations. Forecasting models represent not the relevant activities themselves, but rather, decisions to act together with expected outcomes. Decision models program a specific mode of behavior for the system, both in its current situations and in subsequent situations, as well as possibilities for controlling it and for shifting that mode of operation in accordance with expected changes in the situation. Such models, moreover, possess a clear orientation, namely, to achieve the objective that the system is pursuing and preserve specific parameters.

Decision models represent the primary and uppermost

level of regulating processes, their "matrix" and master program. They are mobile and flexible because systems continually encounter perturbing influences that tend to divert them from the course defined by their programs (their decisions). In cases in which it is not possible, or else, not appropriate to overcome such disorganizing influences through adjustments in regulating activities that are directed towards achieving a restoration of the specified program, a restructuring of the system will take place, or else a new decision will be taken. The range of decision adjustment is relatively wide and includes insignificant adjustments that do not affect or, else, hardly affect the system's program, as well as comprehensive reorganizations of such programs. It is then the modified or new programs that govern the further movement of a system towards its objective. Such changes in programs and adjustments in the system's movement, moreover, occur "in midstream", so to speak, without interruptions in vital activities.

A system's general program, a model anticipating its future is adopted at its highest regulation level. Systems also contain other lower levels that regulate the subsystems that constitute the larger system. These levels are relatively autonomous. The lower the level, moreover, the higher will be its degree of autonomy in relation to the system's highest "programming" level, since links with that level are increasingly mediated as one moves down to lower levels of regulation.

The development of purposeful activities on the part of systems is then a gradual process rather than a discrete one. The regulation subject effects adjustments by comparing current operations and current parameters with those that are specified and by identifying deviations from specified programs that then serve as adjustment signals. Social systems function and move in response to continuous anticipations of the future. As a result of such anticipations regulation subjects are able to conceive and evaluate the anticipated results of regulation activities even before the latter take place.

The regulation of social systems is thus always associated with solutions of problem situations and with the development of corresponding information models.

Attempts are currently being undertaken to identify the mechanism of developing decision models in terms of both its logical and information aspect and its informational-physiological aspect.

In particular an attempt to identify the stages of decision models construction has been made by Prof. J. D. Braverman,¹ of Temple University, the United States. He proposes that a logical model of decisions first be constructed. After it represents the problem under consideration as a specific system, such a model expresses logical relations among the system's components. The symbolic language of logic makes it possible to overcome the insufficient precision and nonunique meaning of thoughts expressed in terms of the categories of natural languages, as well as of the purely quantitative approaches to phenomena that are characteristic of mathematical methods. Naturally such logical models represent highly idealized reproductions of real problem situations since they assume that all system components are known with full reliability.

The second stage refers to a replacement of the abstract logical model through a probabilistic model that is closer to the real situation. In order that the model be realistic it is necessary to identify available sets of different states together with the corresponding sets of different modes of operation. This requires that information about the situation be sufficiently comprehensive to make possible the specification of a frequency distribution of such sets with sufficient precision. In the absence of such information that distribution is defined subjectively, although in such cases, too, a careful analysis of the situation is needed.

The third stage concerns a verification of the probability model through observations, experiments, and an evaluation of the information that is produced. This transforms pre-experimental probabilities into probabilities that are determined after the experiment.

V. I. Chernysh,² a Soviet philosopher, specializing in the theory of information, analyzes the taking of decisions in

¹ J. D. Braverman, *Probability, Logic and Management Decisions*, New York, 1972.

² Cf., V. I. Chernysh, *Informatsionnye protsesy v obshchestve* (Information Processes in Society), Moscow, 1968.

relation to processes that take place within man's brain. In his view there exist distinct centers of decision-taking within the brain. These centers rely on a joint analysis of the organism's internal needs and its external situation in determining the person's current objectives whose achievement is then associated with the solution of problems of a particular class. Each subjective goal is coded in terms of specific basic attributes that determine the structure of the nervous system's corresponding code signals. Object-oriented signals emerging from centers of information analysis within the brain pass through a distributive network of associative relations and enter as inputs into centers of pattern recognition and analysis within which the corresponding models of external situations are recognized in terms of a set of basic attributes. Such functions of search and pattern recognition may be carried out by several specific structures within the corticothalamoreticular and the thalamocorticolimbic systems of the human brain (with hippocamp involvement).

The model of a situation that is then selected operates as a model of "future requirements". An analysis of that model specifies concrete parameter values and initial conditions for the given external problem whose solution then contains concrete means for achieving current objectives. Solutions of such problems ultimately appear as a set of concrete activities and operations and for this reason the corresponding planning, which is a concrete manifestation of the function of formulating and taking decisions, is essentially operational in its nature. The methods employed in solving operational problems include linear programming, dynamic programming, heuristic programming, network planning, and the theory of games.

In cases in which the method of dynamic programming is applied the basic decision model is divided into steps or stages of minimal dimensions. For each of them alternative solutions are considered, and those that are optimal in terms of their particular criteria are selected. Such solutions serve as a basis for the next decision stage, until the overall problem is solved. As a result a decision of the overall problem appears as a sum, or, more precisely, a synthesis of a set of partial solutions.

In the course of a person's life and development new

problem situations continually emerge that call for solutions. As a result of their solution, various types of information-oriented decision models of situations are synthesized within man's brain. It would appear that these models are classified in particular ways, and are stored in special memory structures within the brain. When new problem situations arise the entire stock of information models is "mobilized" and those models are then retrieved that correspond to the new problem situation most closely. Definite associative relations appear to exist between brain structures storing information-oriented decision models and those brain structures that take decisions in terms of new problem situations. These relations appear to make possible an effective and timely comparison of information models of new problem situations with a "collection" of models of situations that were solved in the past, and to identify the one that corresponds most closely to the solution of the new situation, and subsequently to synthesize from these models a new decision model corresponding to a new situation.

In solving new problem situations such information-based decision models are synthesized not only from available complete models, but also from their individual elements and links and from their various combinations, reflecting particular attributes, evaluations, and solutions of partial problem segments. Combined associative models are then developed. In the view of V. I. Chernysh their physiological basis appears to be provided by special mechanisms that guide responses that are automatically activated whenever a new problem is solved. "In the course of guidance processes, there occurs an identification ('a filtration') of informational attributes of the external (or internal) situation, through the establishing of associative relations (direct and indirect) with corresponding associative models in the person's memory (the utilization of both inherited and accumulated experience)." ¹

Social regulating systems represent *multibrain* systems. Such a conception which is, perhaps, not entirely elegant, does nevertheless express the essential element relating to a subject of regulation of a social system at any level, ranging

¹ V. I. Chernysh, Op. cit., p. 60.

from primary labor collectives to society as a whole. The regulation of social systems is carried out by groups of persons and collectives of different degrees of complexity and organization, which are determined by the degree of complexity and measure of organization of the regulation object, that is of the regulated system. It is precisely groups of persons, namely administrative personnel, that receive and process information, take decisions, carry out organizing work on their implementation, regulate the system's functioning, and monitor the outcome of carrying out decisions. Regulation subjects are able to carry out all these functions because rigorously ordered informational-logical relations are established among the persons constituting it.

Regulation subjects influence the object or regulated system through a set of heuristics that represent informational decision models. Essentially, heuristics are programs bearing on the functioning and development of regulated systems that are formed by the subject of regulation in the context of an active influence on the part of the regulation object, in which both the objective of a system's movement and the basic means for achieving it and the identity of responsible persons are defined. Such a program is a set of subprograms, of partial programs corresponding to individual time segments, that are normally executed by the brains of individual persons operating as component elements of the regulation subject and that are related informationally and logically to other elements of the regulation subject. In such a context the nervous system of each person, operates as a specific informational-logical component of the regulation subject's overall informational-logical structure. That component either develops or else carries out some individual part of the overall regulating heuristic. V. I. Chernysh observes that it then "attunes itself" to that particular part of the heuristic, and perceives and processes a rigorous segment of the overall flow of information circulating both within the regulating subsystem, between the system as a whole and its environment, and between the regulating subsystem and the regulated subsystem.

It is in this way that the joint efforts of individuals concerned with regulation develop decision models of problem situations.

CHAPTER VII

INFORMATION SYSTEMS: PROBLEMS OF THEORY¹

Problems relating to the organization of social information and its transformation into forms suitable for the regulation of society are complex as well as important. Their solution requires an analysis of information systems. Let us consider first, the reasons why contemporary automated information systems have emerged.

1. THE NEED FOR CREATING INFORMATION SYSTEMS

Academician V. M. Glushkov, a prominent Soviet cybernetician, has observed that regulation activities are encountering two information barriers that are associated with the growing volume of information.

The first of these appeared as a consequence of a transition from a natural economy, or else, a small-scale economy, to a large-scale economy. This produced a complexification of economic linkages, and it ceased to be possible for the brain of a single person (the head of a family, or the owner of an enterprise) to process the information needed for regulation. That barrier was overcome by allocating regulating functions among a greater number of persons.

The second information barrier appeared approximately in the 1940's as a result of the scientific and technological re-

¹ Materials prepared by V. S. Ryzhov have been employed in preparing this chapter.

volution. The essence of that barrier lies in the fact that the complexity of regulation has increased so much that the total capacities of all persons engaged in regulation activities can no longer process the information that regulation requires.

Already in the mid-1960s, for example, the Soviet Union's economy attained such a measure of complexity that 10^{16} arithmetic operations per year would be required in order to regulate it effectively. Yet, one person employing a hand calculator, cannot produce more than 1,000 operations per shift. Even if he were to work 24 hours a day without interruptions this would represent only 10^6 operations per year. Accordingly, 10^{10} (10 billion) persons would be needed in order to carry out 10^{16} operations per year.

That barrier is being overcome through the creation of modern automated information and regulation systems, in which information is processed with the help of modern equipment and above all, with the help of computers. Computer technology reduces the labor intensity of regulating activities by a factor of approximately 99, and reduces their cost by 80-85 per cent.

The emergence of information systems in regulation activities is a phenomenon that should have been expected. It is well known that a division of labor is taking place within the sphere of regulation and that that process is no less intensive than in the sphere of production. The growing complexity of production has brought about an increase in the volume of regulation activities which resulted in their increasingly detailed allocation among individual workers of administrative structures. Just as specialized workers appeared within production at an earlier time, so persons specializing in particular regulating activities have begun to appear in the sphere of regulation.

Since information passes through all the stages and all the functions, types and forms of regulation, each new specific regulation subunit (in planning, dispatching, accounting services, supply services, and personnel services, etc.) establishes its own and essentially autonomous information linkages with production. This results in a creation of still additional documents, reflecting the same economic phenomena in different forms, together with the emergence of parallel

information flows that largely duplicate each other. As the division of labor in regulation increases, work in the sphere of information requires an increasing volume of the time of personnel employed in production. This is the objective circumstance that has served as an immediate cause for structuring information services as a relatively autonomous branch of regulation, that is, for the creation of information systems.

As a result of a new form of organization of information services it is possible to free production personnel and a large part of the administrative personnel from excessive documentation, to order information flows, assign to specialists data-processing operations that were earlier manually processed at linear and functional levels, introduce progressive working methods among accounting personnel, provide for a single information collection cycle whose output is duplicated separately and presented in appropriate forms for multipurpose utilization by all administrative services concerned (accounting, planning, and supply offices).

A specific form of information systems is selected in accordance with the volume and nature of the work by the corresponding regulation subject. This may be a data processing service, and information center, a computer center, or an Automated Information Management System (AIMS).

The latter represents the highest and most effective form of information systems.

The automation of information processes passes through several stages.

Initially the automation of information processing is largely effected with the help of mechanical means. Mechanical devices, including electronic computers, are then employed to carry out one-time calculations. Accordingly they still do not represent organic components of the system for regulating a given object. Technology is not yet incorporated into the regulation system and merely serves as an external element in relation to it. The preparation of data for processing and, subsequently, the translation of the outcome of machine processing into human language are usually carried out with the help of manual rather than mechanical operations, or else, with the help of non-automated devices.

At a second stage, which is one of partial automation,

regulating systems are created in which the mechanisms are internal to the regulating system. Information is then introduced in a systematic manner, and equally systematic methods of processing it are employed in the course of regulation. The use of mechanical information processing means influence the regulation system substantially. In particular they require a rationalization of information flows, a change in the required set and character of indicators, a transformation of documents and of document flows, etc. Similarly, the composition of personnel within the administrative system must then be altered. An important role is now played by specialists assigned to the technical means of information processing that are employed.

The third stage refers to a complex automation of administrative processes. This transforms information processes in a radical way and synchronizes their flow with both the work of mechanical regulating devices and processes taking place within the system being regulated. The generation of signals about the system's state and deviations in its functioning produces adjustment measures automatically that normalize the system's movement towards the specified objective. The role of individuals is then one of selecting and taking decisions, of elaborating programs and of monitoring the operation of mechanisms. Programs are developed with a view to maintain the desired mode of functioning of the given object in accordance with optimizing indicators. In the case of such systems, the collection of primary data through the sensors located at appropriate points within the object of regulation and other sources of signals is also mechanized. The information that is processed is then employed at all levels of administration to the extent that it is needed for carrying out the functions appropriate to each level. Automation thus encompasses all system elements and all regulation processes.

It should be kept in mind that automated information systems are not identical with the subject of regulation as a whole, which may include Automated Management Systems (AMS). Information systems are only concerned with information, and are not directly related to other aspects of regulation. The task of an AMS is to make possible an optimal regulation of production. While this does require an

optimization of information this is by no means the only function of such systems.

Experience in this area has shown that the creation of information systems must be preceded by a vast *preliminary study of the system itself that includes both the object of regulation and the regulation subject*. It is especially important to study carefully its composition and structure, as well as the tasks that it is expected to carry out and the functional role of the given system within higher level systems. It is important to clearly identify the functions of different subunits of the regulation subject and of its personnel, together with their rights and obligations, to define the algorithms of their work, and to specify the quantity and assortment of information that it requires, as well as the sources and frequency of such information transfers. Only then is it possible to decide which particular operations on information should be automated and what mechanical devices should be employed for that purpose.

Yu. Rudakov, a Soviet scientist, has proposed the following sequence for analyzing systems, which is based on the theory of operations research:

- define the system's boundaries and separate it from higher level systems;
- describe the system;
- divide the system into subsystems in accordance with functional attributes;
- identify the functions of regulation within each subsystem;
- subdivide functions into "work", and "events", work into tasks, and tasks into "operations" and "procedures";
- analyze the correctness of the system's descriptions and of its subdivision into functions and elements, and improving its regulation system through further adjustments;
- define the system's information requirements and prepare to design its information system.

There are two approaches to the design of automated information systems. One of them is guided by the structure of both the information that is generated within the object and that which it receives from its environment. It is assumed that the project director will then find the data that he needs within this stock of information and will employ it. The principal problem concerns the creation of a system of

information retrieval that is simple to use while encompassing large volumes of information.

An increasing number of doubts have recently arisen concerning the effectiveness of such a method, since it does not result in a substantial growth in the productivity of administrative workers. In fact, such systems do not make it possible for a responsible person to receive the precise information that he needs for taking decisions without the help of a large number of specialists in the field of information. R. Ackoff has described such systems which conform to the existing structure of information and data, "management misinformation systems".¹

Since a flood of information is released on the personnel of administrative units, it is responsible officials who suffer most from the resulting abundance of information, for they must take decisions on the basis of whatever information that is available to them. Work with current information requires a large amount of time, namely, 75-80 per cent of the overall time budget of responsible officials. Only 20-25 per cent of their time is given to long-term problems, while, in their own opinion, these problems should be given at least 40 per cent of their time.

While the quantity of information to which responsible officials are exposed is large it is frequently incomplete and unsystematized. Beyond this many communications are altogether useless. As a result, the decisions that are then taken frequently do not take important factors into consideration and are not optimal.

It is not surprising that at the present time preference is increasingly given to information systems that are designed on the basis of an analysis of decisions taken by regulation subjects and responsible officials. These systems are designed in such a way that they supply to its responsible officials the particular volume, assortment, and forms of information that are needed for taking and carrying out decisions. In addition the individual characteristics of responsible officials taking decisions are also taken into account, as is the

¹ R. L. Ackoff, "Management Misinformation Systems", *Management Science*, Vol. 14, No. 4 (December, 1967).

relevant time frame and the scope of the class of decisions that they take.

Responsible decision-makers require at least the following information:

1. With regard to any task confronting their organization:
 - a) the essence of the task;
 - b) the time horizon within which it can be solved and within which it must be solved;
 - c) the number and profile of specialists who will be employed in solving it;
 - d) the amounts and types of resources that will be required for its solution.

2. In situations in which it is necessary to accelerate solutions to individual problems:

- a) when the urgent task may be solved with the help of additional personnel;
- b) precisely what type of personnel may be assigned to the short-term priority problem without substantial detriment to other tasks;
- c) when those tasks will be completed from which a part of their personnel has been temporarily reassigned.

3. With regard to the practical and scientific characteristics of each responsible person within the organization:

- a) exactly what kind of work is being performed by a given person at a given moment;
- b) when and with what result he is expected to complete the work in which he is currently engaged;
- c) how many tasks and what particular tasks has a given worker completed during the entire time of his work within a given organization, and with what results.

At the present time an increasing emphasis is placed on the development of *systems approaches* of the Sputnik and Skalar type to the development of information needed for regulation, particularly for the administration of complex research activities.

These systems are able to indicate at any time "who" is responsible for a problem, or any of its components; "what" the problem encompasses and the nature of its components; "when" both the final and intermediate results would be achieved; "how" and "in precisely what way" (method) the problem, or any part of it, will be solved;

"where" the results will be achieved; "how much" resources are expended on achieving these results.

It is significant that systems approaches are currently being employed increasingly both in the design and construction of the most highly automated information systems and in the preparation of information for decisions. This presupposes an integration of methodological foundations, a unified approach to development of information, an availability of integrated technical services, and an integrated software system.

2. THE ESSENCE AND COMPONENTS OF INFORMATION SYSTEMS

It is thus evident that at the present time the concept of an information system of management may have a diversity of meanings. This results in differences of approach to practical solutions to problems concerning information activities.

A systematized survey of the various views on this problem from a social point of view makes it possible to distinguish between three types of opinion.

Supporters of the first of these do not take the human factor into account at all. From such a point of view an information management system is defined either as a set of operations (methods and procedures) that are carried out upon receiving needed primary information; or as a set of information needed for managing an enterprise; and as a set of means that make it possible to process data.

Similarly a growing number of authors view information management systems as man-machine systems within which both men and machines operate as generally similar elements. Such an interpretation of the relation between them, however, is incorrect. In particular the analysis of existing Automated Management Systems has shown that the relation of man to machines is that of a regulation subject to an instrument of labor just as in any other type of activity.

This is the reason why the third point of view appears to be more convincing. It notes that within the context of the revolution in science and technology *man and his activity*

and labor remain a central element in management. Accordingly his role within an information management system is that of a central element.

The Marxist analysis of labor activities provides a key to understanding the central element of information management systems, including automated ones.

The labor process is viewed by Marx¹ as an integrated system, whose elements are: labor itself, as a purposeful activity on the part of man and an expenditure of human labor power; the object of labor, that is, the object and process towards which human labor activities are directed; and the means of labor, with the help of which man influences the object of labor and transforms it in accordance with specified objectives that correspond to his own needs.

This indicates that *the essential nature of an information system appears to include both man and his purposeful activity (labor) which is applied to information (the object of labor) in order that with the help of computers and other technical means (instruments of labor) a transformation of information be effected into those forms that are needed for taking decisions and for carrying out regulating activities.*

This provides a basis for identifying the structure of an information system's components.

It should be noted that in Soviet literature on the subject the structure of such systems has been represented in a variety of ways. The elements of such systems have been divided into two parts (functional and supportive subsystems), three parts (functional subsystems, structural divisions and information services), four parts (economical and organizational, informational models, mathematical models, and technical regulation systems), five parts (methodological, informational, technical, mathematical, organizational and juridical services) and six parts (technology of developing and processing information, mathematical software, computing complexes, data transmission systems, an organizational scheme of the process for developing and processing economic information, and the systems service personnel).

¹ Karl Marx, *Capital*, Volume I, Moscow, 1964, pp. 173-74.

As a rule, such proposed structures are not inferred from the conceptions of information systems, but are simply postulated often without any additional support. In studying concrete structures it is then not possible to know why they are sometimes described only in terms of two particular attributes rather than three or perhaps six attributes. For example, in defining the concept of an information system in terms of a set of two aspects, namely, "methods and technical means", its structure is occasionally represented as consisting of four components or parts, namely, economical and organizational models, informational models, mathematical models and technical means of automation.¹ It is not indicated, however, why the indicated set of elements leads one to the particular components that have been named rather than to others.

In our opinion it is possible to avoid such inconsistencies by deriving the structure of information management systems from an analysis of their essential nature.

Information processing is a labor activity and an instance of work with information. It is in accordance with the basic elements of that work process that the information system itself is constructed. Accordingly, it includes the purposeful activity of individuals, the object of that activity, and the instruments of that activity.

The principal component of information systems are people, their activities and their labor as it is applied to information with the purpose of lending it a form that is needed for management (decisions, instructions, etc.). Information appears as a specific object of labor, as an object towards which human activities are directed. It is characteristic that this influence is exerted in accordance with specific rules, whose norms must be respected if the required results are to be obtained. The means of operating on information include both equipment and the data and software that it requires, which thus appear as a specific type of instrument of labor. Computers provide the basis for the technical means employed in automated information systems, and a diversity of other means are then related to them.

¹ Cf., O. V. Kozlova, S. A. Lenskaya, *Za dalneisheye sovershenstvovaniye sistemy upravleniya ekonomikoi* (For Improvement of Management System in Economy), Moscow, 1971, pp. 78-83.

Since information-oriented work is primarily a purposeful activity of individuals and a solution of specific problems, let us consider, first, what are the objectives that individuals define in creating information systems, what problems are being solved, and what labor operations are being carried out in achieving these objectives and solving these problems.

3. OBJECTIVES, TASKS AND OPERATIONS

The principal objective and superobjective of information systems is to obtain *from collected primary data secondary summarizing information that can serve as a basis for taking decisions*. As a result, primary information is transformed into *command information*.

Fulfillment of that main task results from carrying out the following more specific tasks:¹

- monitoring of the functioning and development of the regulation object and recording of the values of indicated parameters and of deviations from their normative values;

- collection of primary information describing the state of the object of regulation, and preparation of that information for processing;

- processing of information in accordance with a given regulation program;

- distribution of information among subunits and personnel within the management body in accordance with the functions that they perform;

- display to regulation bodies of processed information needed for the taking of decisions and for developing regulating commands;

- storing and search of information for long-term utilization and its immediate display following a request on the part of users;

- transmission of information from subjects to objects of regulation and back, as well as among different units associated with the subject and object of regulation;

¹ This list is a modified version of a similar list in the study, *Avtomatizirovannaya sistema upravleniya: teoriya i metodologiya* (Automated Management Systems: Theory and Methodology), Moscow, 1972, p. 169.

servicing of information interactions within the given overall system (in the context of integrated needs by subjects and objects of regulation) as well as in the context of interactions with other systems (horizontally) and with higher level bodies (subjects of regulation)—vertically.

In meeting these tasks automated information systems that make it possible to access information which is not available to direct observation and measurement, are especially effective. This is because such systems transform information rather than merely collecting and storing it. They carry out calculations and evaluations of different situations in accordance with a given program. Such systems rely on specified programs in effecting calculations and evaluations of different situations, within which the regulated systems may find themselves, and in comparing and interpreting data which they interpolate and extrapolate. Such automated systems produce a maximum volume of secondary derived (analytical and synthetic) information required for taking decisions and for regulating activities with a minimum of primary initial information.

Automated information systems make it possible to control the state of the regulated attributes of an object at specified rates, to measure and record information on indicated carriers at specified intervals of time and with a specified precision, and also to convey recorded information through transforming devices to human operators taking decisions without auxiliary procedures. This requires that information be subjected to regular technological and algorithmic transformations, that it be reproduced with a specified regularity in accordance with the regulation algorithm, that the substantive contents of information be preserved at all stages of the transformation of information, and that transformations themselves be carried out at specified times. It is especially important to evaluate correctly and filter out precisely that information which makes possible the taking of timely and effective decisions.

The automation of information systems produces a one-time recording of all primary data. At the same time it becomes possible to employ them repeatedly, together with corresponding transformations for different subjects of regulation. The initial data are therefore recorded in universal

data banks, while secondary data, required for specific calculations, are recorded in the libraries of each of the separate regulation subjects.

Automated information systems possess other important advantages as well. They make it possible to overcome the use of multiple channels in transmitting information, and the duplication of reports to different regulation subjects at higher levels. The existence of a single channel provides for a one-time transfer of communications, which are then duplicated mechanically if this is necessary.

Similarly continuity in data processing is made possible. Each calculation recorded on a given carrier may serve as a basis for subsequent calculations without additional manual rewriting or recording.

A unified information fund is created that serves as a common "memory". It is the role of that fund to make possible a centralized storage of all information needed in management, which is then concentrated into specific blocks. This makes it possible for any person requiring such data to access it, to operationally add new data to existing data block and to rapidly access and retrieve required data.

The creation of a well-structured information fund requires the following: that information be unified, systematized and classified; that the terminological and conceptual categories that are employed be made consistent with each other and integrated; that methods for transforming information and its carriers be unified; that a single system of software for information processing be organized; that reliable accumulating devices of sufficient capacity be available, in order to make possible a rapid access to stored data; and that there be devices for remote control over accumulating equipment.¹

The way in which the storage and reproduction of data is organized within an information system is especially important. As the very first step it is necessary to identify the persons who will employ the corresponding information as well as the nature of their needs for information. Next, the data that are to be stored and reproduced must be selected,

¹ Cf., *Avtomatizirovannaya sistema upravleniya: teoriya i metodologiya* (Automated Management Systems: Theory and Methodology), Vol. 1, p. 151.

as well as the way in which they should be classified and associated with indices. Next, the type of means that will be employed for storing information must be defined, as well as the procedures that govern information searches and the dissemination of information. Finally, measures must be taken to update the data that are stored in individual blocks.

Still another task of information systems concerns the *integration of information*.

This refers to a complex utilization of information and to obtaining from initial data that are entered *only once* a maximum volume of valuable information for the widest possible range of decisions both sequential and parallel. The wide diversity of problems that may be solved with the help of given information exceeds by far the particular tasks for whose solution it was initially collected. Beyond this the value of information that has already been entered into a system does not diminish over time and may even increase. That information may be employed in solving other problems that had initially not yet emerged, and for studying the dynamics of processes as well as for its analysis with still more powerful methods and means that bring out its contents and value more fully.

An integration of information is also needed to provide for a unification and integration of all levels of the regulation subject, both vertically (among subordinate levels) and horizontally (among levels that are coordinated with each other).

In such a context the aim of integration is to make available to directing personnel the types and volumes as well as assortments and forms of information that will make it possible for them to monitor the state of affairs in each subunit within the system as well as in the system as a whole and in its relation to its environment, and to take decisions that will make it possible to provide for the system's effective functioning and development.

One may distinguish several specific levels of integration.

The most primary level is concerned with the condensation of information through its expression in terms of rational languages and codes.

The second level is concerned with intergrating information in the context defined by each individual regulating

body. This is achieved through a mutual sharing of information by its subunits concerning internal decisions and communications from the outside, through a suppression of flows of unnecessary information, and through a reasonable combining of centralization and decentralization in information processing.

The third and highest level is the overall central level. It is concerned with a systematization and integration of information that is employed in economic, social, and other regulation and in overall societal regulation.

Large modern information systems integrate information within very large *information banks*, under categories corresponding to particular spheres of social life, sectors of production, science and culture. These are employed by a wide circle of users in solving numerous and diverse problems.

The *overcoming of information barriers* and the elimination of noise or else its reduction to a minimum is one of the most important and difficult problems of information systems.

It is interesting to note that in principle there is no difference between information and noise. That which is information for one person may be noise to another, in the sense of unwanted, useless data. W. Ross Ashby writes that "*noise is in no intrinsic way distinguishable from any other form of variety*". Only when some recipient is given who will state which of the two is important to him, is a distinction between message and noise possible".¹

Accordingly the problem whether a particular influence on a system represents information or else "noise" may be solved only concretely: what kind of system is it and what are its functions, which influences does it assimilate and which does it neutralize or reject. In the social world information (communication) and noise coexist as the result of reflection and interaction among phenomena and processes. Only that part of the outcome of interactions or reflections is information, however, which is accepted and utilized by the system. It is therefore possible to receive informa-

¹ W. Ross Ashby, *An Introduction to Cybernetics*, London, 1957, p. 186.

tion needed for regulation only through overcoming information barriers and noise.

In socialist society there is no barriers associated with contradictions among interests of classes, world views, and the antagonism between subjects and objects of regulation that are characteristic of capitalist society. Instead the basic interests of classes and social groups, nations and peoples, of regulation subjects and objects coincide, and, accordingly, they understand each other and jointly seek to carry out common tasks. Nevertheless a wide diversity of information barriers do exist in socialist society as well.

Geographical barriers are associated with distances between sources and receivers of information. Barriers of this type are overcome through the improvement of the means of transportation and communications. It is impossible, however, to overcome them fully, since the laws of nature do not permit the dissemination of signals at speeds higher than that of light.

Historical barriers emerge because, as events become more removed in time, it is more difficult to obtain reliable information concerning them. This type of barrier is overcome through improving methods of studying the past, and by applying continually improving scientific and technical means.

Barriers of skill are associated with the training of information receivers. General and professional training includes a general level of education and culture, and also an ability to understand the contents of information, as well as a knowledge of information technology, codes and languages. That barrier is overcome through increases in the level of education and skills of individuals working with information, and through a simplification and integration of documents, information languages, and means of "communication" between man and information equipment, particularly, computers.

Administrative barriers result from a certain autonomy on the part of individual territorial units and agencies and from the specific characteristics of the system of information employed by a given agency, as well as from the absence of a smoothly functioning exchange of information with other agencies. That barrier is overcome through im-

provements in the planning system, which links the functioning of individual agencies, the development of interagency linkages and the creation of integrated information banks.

The creation or intensification of administrative barriers usually produces a negative influence on the functioning and development of the given system. For these barriers serve as obstacles not only to outflows of information but to inflows of information as well. The logic which explains this is relatively simple: it is not possible to only receive information without returning anything in exchange to external sources. If, for example, a scientific research institute does not inform other institutes of the outcomes of its studies it cannot expect to receive information from them.

Procedural barriers are established in order to prevent a leakage of secret information. Such barriers are necessary, since some part of social information contains state or military secrets. Yet, these barriers, too, must be overcome. Since few secrets remain secret forever it is important to declassify information in time, when it ceases to be secret. This relates especially to the sphere of science and technology where innovations become either dated or else lose their value altogether.

A rationalization of the exchange of information between military and civilian agencies is then appropriate. Frequently it is in military agencies that the newest scientific developments and technical and technological innovations are first applied. They are then classified, and this is quite natural. Innovations, however, age quickly and it is therefore important to declassify them in time, and to channel them into the economy. This provides an important source for increasing the rate of the progress of science and technology in civilian sectors. It is therefore important to organize wider exchanges of information and of experience in production among different agencies.

Language barriers are produced by differences in the language of the source and of the receiver of information.

At the present time, there are from 2,700 to 2,800 languages on earth, and 200 of these are employed by groups of people each numbering more than 1 million persons. The official languages of international communication, accepted

by the United Nations are English, Russian, French, Spanish and Chinese.

There are more than 100 nations and nationalities within the Soviet Union. As a result of the victory of socialism, however, linguistic barriers to exchanges of information have essentially been overcome. Within the USSR the Russian language has become a language of communication among nationalities and the language of administration of society as a whole in a context in which national languages are preserved within the administrative systems of individual republics.

Increases in exchanges of information with other countries are making the overcoming of the corresponding linguistic barriers increasingly important.

The tested ways of achieving this are a knowledge of foreign languages and translation. While the study of foreign languages is widely practiced throughout the world, translations play a still more important role. Each year the number of translated works increases by 15-20 per cent throughout the world. An important role in such translations may be played by its automation whose possibility at least in the case of science and technology has been demonstrated. Yet the practical requirements of machine translations call for a large volume of preparatory work and substantial equipment. It is therefore not surprising that increasing hopes are being placed on auxiliary languages such as Esperanto. More generally the problems of artificial international languages are studied by a special branch of linguistics, namely, interlinguistics.

Similar to language barriers are *terminological barriers*, which are associated with different interpretations of particular terms. Barriers of this type arise when the producers of information do not make certain that it will be understandable to users. As a result that type of information remains useless. Terminological barriers occur relatively widely in science, especially in "narrow" fields of specialization, as well as in new fields in which an adequate conceptual framework and a corresponding terminology have not yet developed. Particularly, in the early stages of their development new branches of science tend to borrow terminology from established branches (quantum mechanics, for

example, borrowed from classical mechanics) and for that reason, the actual meaning of terms remains poorly understood, while the information that is expressed remains insufficiently useful.

A multiplicity of meanings may attach to individual terms as a result of carelessness in their usage, of an unjustified representation of particular concepts through synonymous terms, or else, of associating different conceptual contents with a particular term. This often produces lengthy, but unfortunately fruitless discussions on the most diverse issues. In this connection mention should be made of the practice of attaching arbitrary interpretations to certain conceptions, terms, and principles of Marxism-Leninism, of quoting these classics that dwell on particular shades of meaning, as well as the quoting of individual phrases and even words out of context. This is undertaken by certain authors with only one aim, namely, to provide support for their own, often quite questionable, assertions.

Different interpretations of terms are especially inadmissible in administration, which is one of the most important and complex types of human and social practical activities.

Since regulation refers above all to an informational interaction between subjects and objects of regulation its success largely depends on the extent to which the language of communication is accessible and understandable to both regulation objects and regulation subjects. Different interpretation by subjects and objects of regulation commands, directives and guiding information, as well as of feedback information leads to interruptions in the regulation process and to serious expenditures and miscalculations.

The association of a multiplicity of meanings with individual terms makes it difficult for those who regulate and those who are regulated and also for specialists, scientists and political leaders, to understand each other, and makes it difficult to produce useful, normative, methodological control and accounting documentation as well as texts.

It is altogether impossible to associate a multiplicity of meanings attaching to individual terms with the utilization of computers. Automated management systems can only function effectively when there is a strict and unique correspondence between the terms and meanings that are cod-

ed, programmed, and entered into the memory units of computers.

The clarification of the meaning of concepts and an integration and standardization of terms, symbols, codes, and signals provide an effective means for overcoming terminological barriers. In such a context mathematics and its remarkable precise and definite language and inflexible logic are destined to play an important role.

Economic barriers appear whenever producers of information do not possess means for meeting the needs of users of information, or conversely, when consumers of information do not possess the means for acquiring information. A reduction in the costs of information and a rational and economic utilization of technical equipment and means of communication help in overcoming barriers of that type.

Similarly, *psychological barriers*, that are barriers deriving from specific characteristics attaching to the understanding and interpreting of information by individuals are both widespread and diverse in form.

On the part of *receivers of information* this manifests itself in distorted conceptions of the events that are reflected in information, erroneous interpretations of signals, and unwillingness or else inability to listen to other persons, a rejection of new ideas because of prevailing stereotypes, intellectual stagnation, biased thinking, exaggerated views of one's own importance, uncritical views of the extent to which they understand the essence of a communication correctly, an inability to evaluate the reasons that have brought about a transfer of information or else to synthesize facts before arriving at a conclusion, and a tendency to arrive at overall conclusions rapidly on the basis of preliminary and incomplete information.

For persons *transmitting information* this includes an inability to conceive the essential nature of the situation, an inability, or else, unwillingness to take into consideration the possibilities and range of conceptions of the receiver of information, the communication of facts that create confusion, the hiding or misrepresentation of the purpose of a communication, the transmission of clearly superfluous information that exceeds the capacity of receivers to as-

simulate and understand it, and the transmission of unorganized chaotic data.

Both in the case of persons transmitting information and persons receiving information additional barriers to information are produced by differences in the general educational level, in professional knowledge and in the level of culture, in the range of their vocabulary, their positions and conceptions, the extent to which they may be dogmatic or categorical in their opinions, and by a confusion of symbols (words) with real events.

In short, psychological barriers are associated with a subjective attitude on the part of persons towards information. Overcoming them requires above all a better training and education of persons, working with information, the development of a sense for what is new and a sense of responsibility and of realism.

Aside from information barriers sources of perturbances and distortions also influence the reliability of information. This includes, for example, incomplete observation and an insufficient range of samples which produce errors in results. Perturbances within physical channels of communication, too, are not excluded (external noises, interruptions, etc.), as well as errors in the coding, decoding, and transmitting of information.

The "purity" of information also largely depends on the structure of regulation activities. As the number of levels on the administrative ladder increases so do the possibilities for distorting information. Frequently this results from the need to coordinate documents of various types. In such cases because of delays in processing it information is not only distorted but may become altogether irrelevant and lose its value.

This calls for the elimination of unnecessary intermediate levels and a reduction of the number of regulation levels to a reasonable minimum.

In summarizing what has been said it should be noted that the exchanges of information among sources and users of information represent a complex and contradictory process.

Information may not be perceived by receivers because of a failure in the capacity of the communications channels

along which it is to be transmitted. This represents a *physical* noise (a perturbation).

Information may be received but not understood by the receiver. In such cases, the content of information remains hidden to the receiver, because of so-called *semantic* noise.

Finally, information may be received and understood by the receiver but deemed to be irrelevant to the solution of the particular regulation problems that are envisaged, even though objectively it may be valuable. In such cases, there is a *pragmatic* noise.

Information systems must minimize physical, semantic, and pragmatic noises.

Minimizing physical noise calls for an effective operation on the part of the technical equipment that is employed in work with information. It is especially important to provide the necessary carrying capacity for channels of communication and an uninterrupted operation on the part of receivers, processing equipment, storing equipment, and equipment for the transmission of information. The minimization of physical noise is thus, above all, a technological problem.

The minimization of semantic noise requires the use of a common system of indicators, classification and nomenclature complex, and a common system of documents, codes, cyphers, and terminology. In short, it requires that a common language adopted throughout the given system will not lend itself to different interpretations. This is achieved by such measures as developing a system of indicators that provide an adequate characterization of all regulation factors, providing for a compatibility of interrelated indicators, and unifying documents and terminology. It is particularly important to create conditions that relate information to natural modes of perception on the part of man and to systematically develop the knowledge, skills, and working habits of persons working with information. The overcoming of semantic noise thus refers not only and not so much to technical and technological factors as to a specifically human problem.

Finally, the overcoming of pragmatic noise requires a clear distribution of functions and definition of rights and obligations among bodies and individuals engaged in regulation and a clear understanding of the volume and type

of information that each participant requires and of the times at which it is needed so that an effective execution of corresponding functions may be possible as well as a consideration of the norms and criteria that information must meet. Accordingly overcoming this type of noise is primarily a human and organizational problem.

Aside from the objectives and tasks that persons operating as subjects of regulation define in establishing information systems, the sphere of their purposeful activity also includes the *operations* that are performed by individuals with the help of technical and other means in processing primary reporting information into final command information. In terms of their essence these operations represent the labor itself that is engaged in the information process, that is as *information work*.

The process of transforming information is repeated periodically and thus possesses a cyclical character because of the cyclical nature of the regulation process itself. The periodicity and time parameters of the cycle are determined by the nature of the regulation object and of the tasks that it confronts. It is then mandatory that the information processing periods correspond to the periodicity of regulation activities. Whenever that time interval is exceeded the processing of information becomes useless since the subject of regulation has already carried out regulating activities in the absence of necessary information. A processing of information that is too early is also undesirable since the situation may subsequently change and a new need for information processing may arise.

In this connection Academician V. A. Trapeznikov, a prominent Soviet scientist, distinguishes three levels of information processing.

The first level refers to the collection of primary data. It serves the identification and recording, usually in numerical form, of knowledge referring to objects and processes describing the object's functioning.

The second level refers to a grouping and generalization of primary data from different points of view, with the aim of arriving at aggregated indicators. These data usually contain information needed for operational planning, regulation, and accounting.

The third level provides for identifying the specific information that is needed for taking managerial decisions.

It is the presence of information filters within systems, corresponding to the third level of information processing and these systems' capacity to identify managerial information and display it to users that transforms automatic information systems into a qualitatively new instrument of management that substantially increases its effectiveness. Any automated information system is always closed in relation to man himself. Academician V. A. Trapeznikov notes that it is also closed in relation to machines to the extent to which the preparation of alternative variants of managerial decisions is automated.

Thus all three levels of information processing result from the purposeful activity of man and from his information work.

The nature and sequence of operations in work with information is defined by the nature of the problems being solved by the system and the level of their complexity.

Frequently the dimension of problems confronting a system as measured by the number of parameters (variables) and by the complexity of the interdependences that are necessary for solving the problem, is employed as a measure of their complexity. While such a criterion is not perfect, especially when applied to social systems, a better criterion has not yet been formulated. In terms of their complexity, regulation problems may be divided into three types, namely, *small-dimension problems*, *medium-dimension problems*, and *large-dimension problems*.

Problems of *small* and *medium* dimensions are solved *algorithmically*, i.e., with the help of either a sequential or else, a parallel-sequential chain of elementary mathematical and logical operations that are carried out in accordance with rules of mathematics and logic.

Algorithms that are relatively simple in a logical, mathematical and informational sense, represent an economical and effective means for solving relatively simple problems. As problems in regulation become more complex, however, and as the volume and diversity of information increase, algorithms are no longer adequate means for its processing. This is especially evident in the case of social information,

which frequently can be neither formalized nor divided into elementary logical and mathematical operations. In such cases, *heuristic* methods are far more effective. This refers to a processing of information through parallel-sequential associative chains of information operations based on rules of creative, nonformal thinking.

The development of heuristic models of regulation objects is then particularly helpful. Such models are able to change their structure through a purposeful transformation of symbols and positions that correspond to changes taking place in the object itself. The structure of models is then changed in accordance with information laws (rules) that are isomorphic in relation to objective laws governing the functioning and development of nature and society.

The high degree of structural flexibility of coded information makes it possible to reflect and record within heuristic models the most diverse traits and properties of objects of regulation and the most diverse changes that they may experience under the influence of different types of perturbing factors.

Heuristic models are homomorphic in relation to actual processes, and in that sense, they are "tied" to the latter. However such "ties" are not rigorously unique in correspondence. This is because the spatio-temporal framework within which the laws governing information processes are applied within models is invariant with regard to the spatio-temporal framework of natural processes and is determined by internal characteristics of information systems. As a result it is possible to combine individual symbols and positions into heuristic models in which transformations are carried out in scales and forms that anticipate the course of the natural events being modeled, which express that course of development in terms of different variants, and which introduce additional factors to the model. All this makes it possible to create within the model either an optimal or a nearly optimal decision variant before embodying that particular variant into practice.

In practice heuristic methods of information processing are often transformed into algorithmic ones. This is associated, however, with a perceptible loss of information since the specific, human forms and methods of expression and of

work with information do not lend themselves to algorithmization procedures and to mathematical and formal and logical representation. Combinations of algorithmic and heuristic operations are therefore employed in work with information for regulation activities. This has produced such a method of purposeful processing of coded information as *heurorithms*, which represents a combination of both mathematical and logical operations that are carried out on the basis of both algorithmic and heuristic rules.

The proportions of algorithmic to heuristic components in heurorithms differ in accordance with the nature of the problems being solved in regulation and the degree of their complexity. They range from algorithms on the one hand to near-heuristics on the other. In solving problems of small or medium complexity and dimensions, heurorithms possessing large algorithmic components are employed. They make it possible to solve problems with mathematical precision and logical rigor. Heurorithms in which the heuristic component is larger are employed in solving more complex problems. The rigor and accuracy of solutions in such cases are based on the introduction of individual algorithmic components into heurorithms. Possibilities for including them increase as the volume of information that is employed in regulation acquires a formal (mathematical and logical) expression.

From an information point of view regulating operations may therefore be divided into the following categories:

algorithmic, which are based on algorithmic methods of information processing;

heurorithmic, in which information processing is based on both algorithmic and heuristic methods whose interaction is synthesized;

heuristic, which are based on heuristic methods of information processing.

Information processing includes operations relating to *coding* and *decoding*, in which information that is recorded in literal and numeric symbols is transformed into a sequence of other corresponding symbols and back again. Coding makes it possible to minimize the volume of information, to carry out transcriptions from carrier to carrier, to prepare information for entry into computers, to carry out its input,

processing, storage and search, and to identify and correct errors in information processing.

Distinctions are made between technological transformation of information in which its syntactic properties are employed and heurorithmic transformations, which are based on a utilization of semantic and pragmatic properties of information. In the first case information is processed for purposes of recording and of transcription from carrier to carrier as well as transmission along channels of communication, etc. In the second case information is processed in order to make it more relevant to the taking of decisions. In both cases, however, the meaning of information is not altered by the utilization of various forms of transformation.

In order to avoid losses of information methods of coding must consider the physical constraints that attach to particular channels of communication and sources of information must be statistically adjusted to these particular channels.

Generally it should be noted that the coding of communications and the process of their organizing in which messages are translated from one symbolic form to a form that is especially appropriate for transmission along particular channels of communication play a very important role in information transmission processes. The speed of transmission of messages depends very largely on the extent to which the coding that is employed corresponds to the communication channel's specific properties and makes possible an overcoming of its noises. Transmissions of information are considered to be most effective when, for a given power of electric signals, the highest possible speed is obtained.

The entire range of operations that are carried out by information systems (by persons assisted by technical equipment) may be represented as follows:¹

the preparation of primary documentation containing required information (man-machine);

the introduction of that information into a computational system (man-machine);

¹ Cf., *Avtomatizirovannaya sistema upravleniya: teoriya i metodologiya* (Automated Management Systems: Theory and Methodology), Vol. 1, pp. 169, 170, 182.

the processing of information for display to administrative personnel (machine);

the display of derived information to administrative personnel for the taking of decisions (machine-man);

the development and taking of managerial decisions (man);

the transmission of managerial operations to the object of regulation (man-machine);

control over the execution of regulating operations (machine-man).

The various operations connected with the work with information may be classified on the basis of Marx's understanding of purposeful activities from the point of view of the contents and methods of their execution.¹ From the point of view of its *content*, information work constitutes a combination of regulating operations that are performed on information and its carriers. The *method of execution* defines the order in which processing takes place. This indicates that a classification of such operations must be carried out in relation to two aspects: namely, the content of informational work and the method of its utilization.

The nature of the operations that are carried out in concrete information systems may vary considerably. Generally, the initial operation is the recording of data, while the final operation is the conveying to users of the information that they require. Between these two stages, working and control operations are carried out. They may be combined into three types: primary, preparatory, and principal operations. A collection of data takes place at the first stage, which at the preparatory stage are transformed into the type that is appropriate for entry into an information block, and a processing takes place at the principal stage.

Collection operations include the recording and transmission of data. With the help of recording, a registry of initial information is effected, or else, a message is prepared. Transmission operations make it possible to move data in time to places at which the next activities will be carried out. The next stage combines operations of receiving, editing, and formalizing data. In the course of receiving infor-

¹ Cf., K. Marx, *Capital*, Vol. I, p. 174.

mation, a verification of the correctness of the composition of the message is carried out, in the sense of its correspondence to accepted standards and juridical norms. In the course of editing messages that are to be entered into information blocks are extracted from the received communication and integrated. With the help of formalization procedures the data that are being accumulated are transformed into a form in which they may be entered into the information block. The third stage, namely, processing, includes operations of the entry, storage and processing of data in accordance with given algorithms, as well as the output of information. Entry operations provide for data concerning the course of productive activity and their reduction to a form that is employed in storage operations. In the course of storage a systematic accumulation of data takes place that contributes to a synchronic finding of needed information. As specific logical and arithmetic operations are applied to the processing of data blocks, initial information is transformed into output information. Its output provides for a reduction of the "raw" outcomes of a solution to the problem into a form that lends itself directly to a "utilization" of output, and which is conveyed to users within specified time constraints.

Two modes of operation of information systems may be defined in terms of the method of execution that is employed, namely, the sequential mode and the parallel mode. Under a sequential mode, operations are executed one after another, while under a parallel mode they are executed together. Systems operating under a sequential mode may be divided into three classes: those that are based on one-time operations, those that operate in a package mode, and those that operate in a time-separation mode. The one-time mode presupposes the processing of messages as they come: first, a recording, transmission and receiving of a single message are effected, then, a recording, transmission and receiving of another, and then, in the same sequence, of a third, etc. Under the package mode of operation messages are processed in groups (packages): the entire group of messages is first recorded, then they are all transmitted along communication channels. Finally, under a time-separation mode of operation the extent to which individual operations are car-

ried out with respect to individual messages is regulated by available time: first, for example, the recording, transmission and receiving of one message are effected, then, if a reserve of time still remains, the recording and transmission of another message, followed by a continuation of the processing of the first message which is edited, formalized, etc. This provides for a simultaneous access to the information system by several clients.

Parallel modes of operation may also be divided into three classes. In the first case, different operations of the processing of a single message are executed in parallel mode; in the second, one operation that is carried out in relation to different messages is executed in parallel; and in the third, data processing operations are carried out in parallel with the real processes that these data reflect. Information systems then operate in the following corresponding modes: the multiple operation mode, the multiple channel mode, and the real time mode.

Information processing is carried out in accordance with specific rules.¹ These include the following:

rules of constraint that are imposed on exchanges of information (relating to existing channels for transmitting different types of information into the information subsystem, the maximum admissible number of repeated transmissions in each channel, etc.);

rules relating to the selection of channels for transmitting information (for receiving needed information about the state of the information network or of its elements; the selection of channels for transmitting information on the basis of full or partial information concerning the state of the network; and the organization of selected channels of transmission of information);

rules relating to the transformation of information flows (choice of identical information arriving through different channels; the duplication of information being transmitted in order to convey it to users along all or some particular

¹ Cf., I. A. Mizin, *Voprosy peredachi informatsii v bolshikh sistemakh upravleniya* (Problems of Information Transmission in Large Management Systems). In: *Bolshiye sistemy: teoriya, metodologiya, modelirovaniye* (Large Systems: Theory, Methodology, Modeling), Moscow, 1971, pp. 145-46.

channels; the generalization of information in order to reduce the number of initial flows);

rules relating to the servicing of various sources and users of information depending on their position within the system;

rules relating to the servicing of different communications, depending on their importance and urgency, including priorities for interrupting communications of lesser importance.

The analysis of information systems from the point of view of the objective pursued by the operations that they perform represents a necessary but not yet a sufficient condition for its design and construction. Such an analysis merely provides a conception of the nature of the information work. Next, it is necessary to establish the object of labor, that is, the object towards which labor activities of individuals are directed within the information system.

4. THE OBJECT OF INFORMATION WORK

The concept of an object of labor, as understood by Marx, refers to the object towards which the labor of individuals is directed and which human activity changes in a useful direction. In the context of information work the object that experiences such changes is *information, and above all, primary information*. By carrying out the specific goal-oriented operations that have just been described, it is transformed into a reference, a summary, a balance, a forecast, an advice, a plan, etc., i.e., into a form that is useful for the taking of decisions and for carrying out regulatory commands.

This refers, moreover, to social information in a form that integrates its essence, content, and form of expression. In the second and third chapters, we have considered the essence of specific properties of social information and an attempt was made to classify it. Now we shall consider the material forms into which information is embodied and which represent the object of *information work*.

Information systems and individuals working on information are concerned not with information generally but

with concrete information that is embodied into specific material forms and structural units.

The structural units of information refer to flows and blocks of information, models and languages, signs, codes, and signals.

Flows of information describe its dynamic aspect, its movement, and its subdivision into types and subtypes that depend on the source and function of regulation that they serve, and on direction, boundaries of circulation, spheres of application and other attributes.¹

Since the information that is received does not vanish and is not destroyed fully, that part of it which may be employed in the future is stored in the form of corresponding documents and is concentrated in storage devices of various types including the "memory" of electronic computers.

Data blocks represent the location of information in documentary form, or else, some other recorded form that is known to both its source and user. The source delivers information to the block in which it is stored, in which it is systematized in an appropriate way and from which it is forwarded upon request to users. Such blocks are concentrated in archives and libraries, special information centers and in the case of automated systems in the memories of computers.

Blocks of this type represent an organized and systematized storage of information. While they are basically stationary, such data blocks are also subject to change. Information is added to their basic stock, or else information that has lost its earlier value is deleted from them. Such stocks of information are subject to change at any given moment in time. Information is employed by users within the location of the block of information itself or in copied form which is forwarded to users either permanently or temporarily, and along channels of communications.

Information blocks are characterized by the following parameters:

the volume of a storage device, i.e., the size of the space that is available for storing information;

¹ Cf., Chapter III of this study.

the volume of information stocks, i.e., the quantity of information that is contained within a block;

the quantity of new information being added to the block at a given time;

the quantity of information that is being deleted from the block per unit time, either because it is no longer required, or because there is no longer space for storing it.

the quantity of information that is employed by users;

the content of blocks, i.e., the nature of the information that is stored within them;

the measure of operational servicing of users, which is expressed in terms of the time interval that is required from the time of request to the time of receiving information.

An important problem that is confronted by individuals responsible for information blocks is the need to concentrate the greatest possible volume of information of high value into the least amount of space. A solution to that problem is made difficult by the fact that as the volume of useful information in a document declines the number of such documents increases. If one avoids adding new materials with low information content to existing stocks, then the information block will be deprived of that information. If, on the other hand, the stocks will be systematically increased, then there will not be enough space for storing that information.

That contradiction is resolved in a number of different ways, and above all, through the careful content analysis of information and the extraction within it of generally valuable information. To find what is valuable, however, is only half the task. It is also important to embody what is valuable in a form that will yield a maximum information with a minimum text. This is the purpose of numerous reference journals, summaries of individual studies, short summaries, etc. An economizing of space in storage devices may also be achieved through the use of microfilm versions of original documents. This is a field in which important achievements have been recorded in recent years. Modern techniques make it possible to produce copies of documents that are hundreds and thousands of times smaller in size than the original. Thus, for example, the microfiche version of *Collected Works* of V. I. Lenin which has been pro-

duced in the USSR consists of 55 transparent micro-slides. The size of each of them is 75×125 mm and each contains all the pages of a particular volume. The capacity of such a card is 936 pages. The micro version is smaller than is the original. Such cards are stored in special envelopes which are collected into albums. The entire fifth edition of 55 volumes of *Collected Works* of V. I. Lenin is contained in an album whose size is $117 \times 85 \times 30$ mm.

Finally, very great possibilities for minimizing the spatial dimensions of information are provided by mechanical information carriers such as punched cards, magnetic tapes, and magnetic discs.

Depending on the extent to which the contents of information stocks are employed they are divided into *substocks*. These include:

- operational stocks—those which are most widely employed on a daily basis;

- working (basic) stocks, which contain information that is employed but not as frequently as is operational information;

- passive (reserve) stocks—with a low measure of utilization.

In order to adjust the state of information blocks and stocks to actual needs for information, a systematic cleansing of obsolete materials takes place. This is based on the concept of *half life* which refers to the measure that describes the length of time during which the need for human information is reduced by a half. The half life of different types of social information varies from one or two years to ten or more years. Scientific and technical information in advanced branches of science and technology tends to become obsolete especially rapidly.

In connection with the very large growth in volume of information and the abundance of information blocks and stocks the organization of rational search methods for information is currently acquiring a major importance. Traditional searching procedures (catalogues, bibliographic manuals, subject catalogues, indexing systems, etc.) are being supplemented and to an increasing extent replaced by mechanized and automated means of information retrieval based on the use of computer technology.

Information retrieval systems are used more widely. These represent long-term recording devices for storing and rapid searches and displays of information needed by users.

One of the basic principles on which the functioning of information retrieval systems is based concerns the principle of relevance, that is, the correspondence of the meaning and content of displayed information to the request that has been received.

Such systems include manual, mechanized, and automated devices for searching information.

It goes without saying that automated management systems also presume the availability of automated information retrieval systems. Centralized data blocks of information are then created that are stored on internal machine carriers and associated with specific zones of its external memory in which codes of attributes of the requested information are contained. The needed information is automatically conveyed to users either directly or through channels of communication.

Automated information retrieval systems provide for a minimization of information, and for a capacity to store large volumes of information in compact machine-based carriers. They make possible a convenient selection of information with low access times from large blocks of memory, an operational entry of changes and additional information into available blocks and a rapid execution of recording and reading of information. Such systems belong to the category of mass service systems. The number of clients who are served depends on the nature of the information system and the availability of equipment for processing it as well as of communications channels with clients.

Information retrieval systems may be divided into documentation systems, which display references to documents containing the necessary information, or else, copies of documents and the addresses at which they are stored; facsimilographic systems which display the needed information directly; and informational and logical systems, which first process information that is entered into the system and then display new information.

Let us consider the structural units of information. A large role attaches to information models, which represent

a system of sentences, words, graphs, formulae, and tables, etc., that simulate the overall regulation object, or else, its components and aspects.

Models that are constructed in accordance with the rules of mathematics are mathematical models (for example, mathematical formulae and equations and combinations of equations). If they are constructed in accordance with the rules of logic, they are logical models (sentences, combinations of sentences concerning a natural object, etc.); if they are constructed in accordance with heuristic rules, they are heuristic models (conceptions and images developed within man's mind and reflecting particular natural events).

All such models ultimately possess an *information* character referring to the sphere of thought that makes them especially valuable in the study of social systems and regulation processes. This is because social systems are inevitably associated with persons and their situations, interests, and needs, and accordingly, real experimental transformations are frequently impossible.

In such a context, analogue models assist in carrying out both studies and practical activities. They do not interact directly with the original and do not influence it. At the same time, they reproduce it in the form of thought. Model parameters are measured, transformed and compared to the properties of the original phenomenon. In that process the model itself is compared, refined and made more comprehensive, reflecting increasingly new properties of the original phenomenon. Eventually this transforms it into a thought image of the object.

Experimental games are carried out in which changes in models are studied that take place under the influence of either natural external or internal influences, or else as deliberate operations of a regulatory nature. Causal relations between regulating operations and consequent outcomes are identified as the dependences are given a quantitative form.

Models represent a specific form of organizing information of phenomena and processes taking place in a particular system. That information represents an object of study and man processes and transforms it with the purpose of obtaining variants of solutions and of preparing them and

evaluating them in order to select the best. In other words, the information that is obtained as the result of modeling is employed in taking or else correcting decisions and in identifying actual regulating influences on real objects of regulation.

The modeling of information concerning regulation operations requires the following: determining objective functions and the definition of rules for selecting decision variants; the construction of an hierarchical structure of operation elements; the identification of inputs and outputs for individual operations; the identification and measurement of information linkages and flows; the preparation of a mathematical description of operations and the sketching of a system of communications for information transmission; the design of a system of documentation with due account of mechanical information carriers; the design of algorithms representing individual operations; the design of a mathematical program on the basis of these algorithms; and an evaluation of technical information processing devices.

As production processes develop and become more complex and as further progress occurs in sciences, technologies and cultures, the objects studied by man have revealed additional aspects of their existence. As a result their description in terms of the usual languages (verbal descriptions) has become increasingly lengthy and inconvenient. This has led man to create *representations*, that is multidimensional models based on graphs. They include a diversity of types of maps (geographic, topographic, geological, nautical), plots, electronical and electrotechnical charts and blueprints, scale models, etc. Because they are based on shared conventions among persons, they constitute symbols that contain large amounts of information in a compact and visually meaningful form. There exist entire spheres of social life, and in particular military affairs, in which visually convenient representations and symbols have almost entirely displaced verbal descriptions. Maps with corresponding symbols and three-dimensional scale models have become the main source of information employed in the management of military units.

The advantages of such representations include the following: that they reflect a specific physical reality about

which they convey information; that they represent abstract symbols of which a large part lends itself to mathematical formalization; that they serve as visually suggestive carriers of information, a feature that is especially valuable in the establishing of mutual understanding among persons employing different natural languages; that they are able to express real situations at any level of complexity; and that with their help it is possible not only to arrive at possible decisions but to visualize them and visually sense their significance. This is the most important source of the heuristic value of such representations.

Graphs provide one of the most effective means for expressing information. Corresponding types of information displays are relatively numerous. They include the following:

- diagrams and curves expressing quantitative relationships;

- plans and topograms describing the location of objects in space;

- chronograms that describe sequences of events over time;

- cyclograms and linear graphs describing the movement of objects in both space and time;

- classification schemes in which objects are grouped and classified;

- orgograms that describe the internal structure and external linkages of systems;

- and network graphs, which model processes of planning and management.

Network graphs that are employed in network planning and management systems are especially useful.

Network planning and management methods are particularly valuable because they make it possible to supply the regulation subsystems with sufficient and reliable information that is made available, moreover, in a systematic operational way. This information describes the state of regulation objects, and the process of plan execution as well as its outcome. This makes it possible for the regulation subject to be continuously informed about the particular operations that are being carried out in each time period as well as about the identity of responsible persons and the degree

of success that is attained. In this way regulation activities are made continuous, flexible and operational.

The rational organization of information processes makes it possible for a network management system to continuously control the problem situations and to enter adjustments as well as to forecast the course of events.

Attempts are currently being made to create tangible three-dimensional information models for the management of scientific research activities. This includes, for example, the systems named Sputnik and Skalar which have already been mentioned. They are three-dimensional representations of organizational situations that facilitate substantially the process of accumulating information and, thus, the perception of current situations relating to problems of considerable complexity. This makes it possible for responsible persons to take necessary decisions in an operational manner thus providing a basis for effective management in implementing programs of scientific research.

Languages and words as well as vocabularies of words in natural or else artificial formalized languages constitute still another structural unit of information that is available to man in the context of information activities.

Living natural languages provide one of the basic means of information interaction among persons in the course of regulation activities. They possess both information properties (they contain information) and communications properties (they provide for communication and for mutual relations among individuals).

Languages serve as the most perfected and most reliable and specifically human social means for communication and information. As a means of communication among persons they may not be compared with any other sign system. Beyond this all sign systems employed in social regulation originate from and eventually flow into systems of language signals. Ultimately the value of modern computers and of the signs that they employ are determined by the extent to which machines are able to "speak" in human languages and to translate these languages into their own and then back again.

Above all regulation represents a creative activity based on the thought processes of persons who are social beings

and members of specific collectives. In the course of regulation activities individuals communicate with each other and exchange thoughts, but ultimately there is no other means of communication in society than languages. It is only through languages that thoughts can take shape, be stored and be transmitted and received. And without such movements of thoughts embodied in information regulation activities would not be possible.

Living natural languages are characterized by an exceptional wealth of possibilities and a multiplicity of meanings. It is in this respect that they differ most from signal systems employed in the world of animals in which each signal possesses a rigorously unique meaning and corresponds to a single specific situation (for example, each of the sounds produced by anthropoids corresponds to situations representing danger or else feeding). The multiplicity of values associated with human languages and the existence of synonyms within them makes it possible to represent with relatively few words a great number of objects and phenomena in the world and to express the most refined shades of feelings and thoughts of persons as well as their changes under the influence of changes in reality itself. Naturally, misunderstandings may arise in the course of communication and the exchange of information based on natural languages, but these may be overcome in the context of specific situations in a manner that leads persons to arrive at a unique usage of expressions. It is therefore not accidental that languages make it possible for persons of different ages and professions to successfully exchange information. This requires, however, adherence to the following rule: individual words must not be confused with others that are close in terms of their meaning.

Natural languages are also able to serve information systems in which data blocks and data funds are embodied in those particular living languages in terms of which the user of information operates. This refers to libraries, archives, and centers in which information documents are stored and made available to users in their natural original form (either as originals or as copies).

At the same time, natural languages "do not work" in the context of automated systems for storing, processing and

transmitting information with the help of computers. In such cases *artificial or formalized* languages are employed.

As automated information systems are used more widely the development of artificial languages is further intensified. In this connection one observes two trends. One is a striving to integrate and unify natural languages in order to be able to apply them to a solution of as large a set of problems as possible. The language PL-1, for example, is such a universal language. The second trend is a specialization of languages in solving specific problems. This is true of such languages as COBOL, TABSOL, ALGEM, and ALGEK, which are employed for solving problems in the area of economics, and ALGOL-60, MAD, FORTRAN, which are employed for solving scientific, technical, and other problems.

Each of these groups of languages possesses both advantages and disadvantages. The first group makes it possible to solve a large set of problems, but its effectiveness is limited since the specific properties of the areas to which languages relate are not taken into account in universal languages. The second group makes it possible to solve a limited group of problems, but since these languages consider explicitly in their codes, indices, and code combinations the particular areas to which the problems being solved relate, their possibilities in processing information are relatively greater and so is their effectiveness.

The nature of languages and the boundaries within which they can be applied constitute an important theoretical as well as a practical problem. This is because, in connection with automation, and especially in the context of large systems (this refers to production associations, industries, as well as the national economy as a whole) the problem of the information compatibility of computers is extremely important. Yet programs employed in one type of computers may not be applicable in other types of machines. Two methods exist for solving that problem. The first relates to a universalization of languages applied in programming the solution of problems in computers. These are languages of a special type which are oriented on machines rather than on types of problems ("machine-oriented languages"). The second is a unification of different types of machines in order

that it may be possible to employ a smaller number of languages. In the Soviet Union, for example, only three types of computers are currently being produced instead of the twenty or so for the second generation.

Aside from specialized and integrated artificial languages there exist languages for receiving, transmitting, storing and processing available information (descriptive languages). These languages do not participate in creative work and are based on a direct parallelism between the content of information and the forms in which it is expressed in a language. This is true, for example, of the language employed by the scientific information services of chemistry. It is employed for retrieving information about particular chemical objects with the help of information-logical machines.

"Operational languages" on the other hand are, as V. S. Tyukhtin has noted, an altogether different matter.¹ Within such languages a leading role is played by mediated forms of correspondence as well as by elements of direct parallelism in contents and forms. Procedures and processes for receiving new information are distinct from the structure of reflected objects. Such artificial languages contribute to creative work and in obtaining new information. They serve the programming of operations of computers possessing self-teaching and self-organizing as well as pattern recognition capacities. The development of these languages, however, and the programming of computers in terms of their categories has only recently begun and is not yet being applied to operations relating to social information in any useful way.

Artificial (formal) information languages may be divided into the following types:

classification languages, which are applied in referring to objects in a context of processing and retrieving information; they are based on a systematization of reflected objects and on the use of distinguishing characteristics of each group of objects expressed in terms of particular codes;

descriptor languages, whose elements are descriptors, that

¹ Cf., V. S. Tyukhtin, *Otazheniye, sistemy, kibernetika* (Reflection, Systems, and Cybernetics), p. 202.

is, words or combinations of words borrowed from a natural language that express rigorously specified conceptions; descriptors exclude synonyms and homonyms;

algorithmic languages, which refer to programs and instructions defining the composition and sequence of formal operations that are employed in processing information on computers;

machine languages, which are applied in describing algorithms for solving particular problems on computers.

While this may sound paradoxical formalized information languages represent a definite step backwards towards the structure of animal languages, since their principal trait is terminological uniqueness. In creating artificial languages, including machine languages, the multiplicity of meanings of natural languages is overcome even though this does not exclude the possibility of teaching machines languages that may be close to natural languages and that retain its principal characteristics.

Communication between man and machines require a certain compromise between the freedom of natural languages and the formalization of machine languages.

Signs refer to letters, numbers and conventional notations that are applied in natural languages.

They constitute a specific substitute for real objects, phenomena and processes in which the latter find a specific reflection. Individual signs do not provide adequate information concerning the object that they represent, that is, its components, structure, and functions, and are not subjective images of such objects. Only systems of signs are able to produce such images.

Nevertheless each individual sign carries a definite load of information in the sense that it replaces a definite object from the informational point of view and corresponds both to the object and its image. Object-image-sign relations constitute an elementary scheme and the simplest case of coded information that translates it from an image into a sign. A sign always represents at the very least the presence (or absence) of an object and removes the uncertainty of images of its existence or nonexistence. Signs make it possible to select a needed object from a variety of objects or else a needed operation from a variety of operations and, hence,

convey information needed for regulation (for regulation always constitutes a choice) even though they do not identify the contents of the object (or operation).

A sign does not reveal all the information about an object but rather its informational invariant, that is, that part of information which is common to both the image and the object.

The information that is represented by a given sign is called its *significance*. Since the sign denotes (encodes) both the object and its image there exist two conceptions of significance, namely, an object-oriented one and an image-oriented conception (in terms of meaning). In the first case significance is viewed as a correspondence of the sign to the object being denoted, at least in the sense that the object either exists or does not exist or that the object exists either in reality or else in the consciousness of a man. The object-oriented significance of a sign is justified and useful in the solution of logical-semantic problems, but it is clearly insufficient or more specifically inapplicable to the solution of problems in the logic of epistemology. In the latter sense significance is viewed as a correspondence of the sign to the image of an object. A mental or sensory image that is represented by a sign represents its image-oriented significance (or meaning).

Because the object-oriented or meaning significance of signs are one and the same, significance in its integrated sense (a unity of object-oriented significance and of meaning) appears as information that is simultaneously inherent in both the object and its image. It is characteristic that in moving from an object to its image or sign there occurs a loss of information.

In practice information concerning an object is infinite, at least in a potential sense. An image reflects only that part of this information which is required by the system. And it is precisely that part which is expressed in a sign.

Aside from information about objects and their images signs often contain information of a subjective nature that characterizes the attitude of persons (subject of regulation) towards objects and images. In other words encoding systems that create signs introduce additional information into signs that is associated with pragmatic purposes. Pragmatic

subjective aspects are especially apparent in the encoding of social information, when persons belonging to different classes and possessing different interests and tastes associate different and often directly contradictory contents of a given sign (word). This shows (once again) that a cybernetic formal-logical approach to social information is not only limited, but that it is simply inapplicable in circumstances in which information serves to express class interests and contradictions.

Naturally a multiplicity of meanings interferes with a rational organization of information processes and, therefore, with regulation. It cannot be justified in those cases in which signs and practice have established a more or less precise meaning for particular signs. In those cases, in which such precise meanings have not been established it is necessary to secure precision with the help of both substantive and formal-logical means.

There exist three types of rules governing operations with signs:

- syntactical (relations among signs);
- semantic (relations between signs and the objects, activities, relations, processes and the properties that they represent);
- pragmatic (relations between signs and persons applying them).

In the case of social systems signs and especially those of a complex nature (formulae, equations, tables, graphs, charts, etc.) play a very large heuristic role and make it possible to express information not only about elementary objects (signs) but also systemic objects (complex signs).

Signs as a form of expression of information inevitably imply codes that represent the meaning of words (signs) of natural languages in a formalized language. In other words codes are images (substitutes) of words of natural languages represented in terms of symbols drawn from an artificial language. Symbols are constructed in such a way that they may be understood by both persons and entry devices of computers. The choice of a code is determined by the degree of its applicability for solving particular problems, by the amount of time and means that is needed for processing information, and also by the type of machine

that is employed for processing information. In developing a coding system it is important that the code correspond to the object that it represents in a unique manner, that it reflect the identity and differences of objects, that it point to the position of an object within a classification, and that it contain a minimal number of symbols. Codes may be based on letters, numbers, and on combinations of both. Classifiers are developed for encoding each combination. These are systems of groups of objects belonging to the given combination.

A distinction is drawn between natural codes, on the one hand, and signs that have developed as a result of interactions between a system and its environment in the course of its evolution, on the other. An example of the latter is provided by the genetic information code which is the outcome of the emergence and development of living organisms. Living nature does not possess any codes and signs other than natural ones.

Unlike in the case of living nature, societies make wide use of artificial signs, sign systems, and codes as well as natural signs in regulating social systems. These are created by men in order to solve specific problems and unlike natural codes they often represent a selection from a large number of possibilities. They represent the outcome, moreover, of a conscious conventional agreement among men.

Both signs and sign systems as well as codes are forms of expression of contents. Accordingly they possess a relative independence from the contents of information that is stored, transmitted, and processed through their use. The same information may be expressed through different signs and codes. The development of information technology is proceeding primarily in relation to its capacity for retrieval and developing code systems that make possible more effective operations on information.

Finally, signals constitute the final carrier of information and that form of information which makes it possible for man and machines to perceive information. It has already been noted that the signal form of information is a necessary property of highly organized self-regulating systems, and that in the case of social systems it is words (spoken or written) that play the role of final signals from

which information derives and into which it eventually flows.

In the case of biological systems, signals fulfil an adaptive and orienting function, thus contributing to the system's preservation and development. In the case of social systems signals play a warning (external) and expressive (internal) role and fulfil communication and regulation functions. In the case of technical (automated) systems, the most diverse forms of signals are employed. Ultimately, however, they are all derived from human verbal signals.

Flows and data blocks, stocks, models, languages and other objects of man's information work within information systems are usually embodied into *documents*. Documents are material carriers of information. They appear as a means for recording information in different ways and on different materials.

Information that is recorded in the form of documents need not be a document in the familiar sense. A document is any carrier of recorded information providing for the possibility of its subsequent reading without significant losses, as well as its storing, processing, search and transmission.

Documents must meet legal requirements and also lend themselves readily to manual and machine processing. They must contain the needed data both quantitative and qualitative, and make it possible to enter desired changes.

Most documents in this sense have the form of written documents.

Those written documents which are employed in management may be divided into the following basic types:

- directives, orders, instructions;
- assignments, permissions;
- norms, normal values, reference manuals;
- lists of resources;
- accounting documents;
- reports and accounts;
- technical documents (blueprints, technical specifications, etc.), programs, instructions, methods;
- business correspondence, administrative resolutions;
- state laws and statutory instruments;
- legal documents;
- documents containing scientific information.

Within the economy of the USSR and more specifically within its system of economic regulation there currently circulates an enormous volume of various documents (over 4 billion each year) that serve as carriers of information. Each year approximately 250,000 documents are produced by only some of the larger enterprises and over a thousand types of documents circulate in some of the engineering plants.

Computer information, which is frequently displayed in the form of documents, is a special form of documentary information that is produced by the processing operations of computers.

In the case of automated systems, both perforated and nonperforated cards (80 column cards and cards with perforations along the margin) as well as perforated tapes, and magnetic carriers (magnetic cards, tapes, discs, matrices made of ferromagnetic units, etc.) constitute information-carrying documents.

A modern document that can be entered for machine processing consists of three parts, namely, information proper, a text in which the information is embodied, and an auxiliary device. The latter may be of a traditional type (title, author, index, short annotation, etc.), or may be a nontraditional cybernetic auxiliary device that makes it possible to enter information into a computer and to retrieve it for automatic display (perforated tapes, perforated cards, magnetic tapes, etc.).

Each document possesses a definite *information capacity*, i.e., a quantity of information that it may carry. The information capacity of a document is characterized by the number of descriptors that are available, that is, of meaningful words or combinations of such words with nonmeaningful service words. The capacity of a document largely depends on its style. A precise logical and a concise style serves to increase capacity.

The information capacity of computer memory units has been increasing very rapidly. Magnetic discs and tapes are being created on which it is possible to record hundreds of millions of symbols (numbers and letters) that store information equivalent to hundreds of thousands of volumes of 500 pages each. As a result it is possible to create gigantic

repositories of information, including nation-wide data banks.

Still another characteristic of documents is their information capacity, i.e., the quantitative information that is useful to a specific user. In determining the information capacity of a document a dictionary of descriptors is prepared that corresponds to the needs of the given user. Documents are described with the help of such a dictionary. The system of descriptors characterizing a document constitutes its search image. It makes it possible to solve retrieval problems associated with the search of documents, carry out a verification of performance and collect information concerning the state of objects listed in a document and do other operations.

In order to facilitate and accelerate the retrieval of a needed document within large information banks standard rules for specifying the forms of documents have been developed. This refers above all to such auxiliary elements as titles, annotations, and summaries that make it possible to learn about the basic content of a document without examining the original. This is facilitated through the use of the internationally accepted Universal Decimal Classification (UDC), of cards with perforations along their margin, of goal-oriented perforated cards, of superpositional perforated cards, of machine perforated cards, and of other forms of matrix documents.

A necessary requirement for documents employed in automated systems concerns their standardization and unification and the use of common classification and coding.

5. MEANS OF INFORMATION PROCESSING

It has been observed by K. Marx that an instrument of labor is "a thing, or a complex of things, which the labourer interposes between himself and the subject of his labour, and which serves as the conductor of his activity".¹ In the case of work with information, man places between himself and the data to be processed both technical equipment and software.

¹ K. Marx, *Capital*, Vol. I, p. 175.

Five types of technical means for work with information are usually distinguished, namely, means for receiving and reflecting information; means for recording and storing information; means for duplicating information; means of communication; and means for the logical processing of information.

Technical means of information processing evolve together with progress in science and technology and with growth of volume and "assortment" of information. Initially, such relatively simple instruments as abacus, arithmometers, and electromechanical desk calculators were produced. Subsequently, calculators based on perforation patterns were developed that were able to carry out automatically sequences of labor-intensive operations over large volumes of data.

None of these, however, was able to solve the problem of operational processing of a continuously increasing volume of information in a radical manner. For the speed of information processing depends on the physiological capacities of man and these, as is well known, are limited. Accordingly, the range of operations that they may carry out is also limited.

A genuine revolution within the sphere of work with information began in recent decades following the development of ideas associated with cybernetics and of associated mathematical disciplines (communications theory, coding theory, the theory of algorithms, discrete analysis, etc.) and in connection with the creation of rapid electronic computers. Electronic computers represent a universal means for processing and analyzing information. They make it possible to solve all problems that may be reduced to a specific sequence of formal logical operations.

Computer technology has been advancing with extreme rapidity. It is estimated that its average period of full renovation is five years. Between 1955 and 1970 three generations of computers succeeded each other, and at the present time a transition is taking place towards a fourth generation.

With each new generation, changes take place not only in the material basis of computers but also in the rapidity of operations. At the same time their intellectual capacities increase.

The principal elements of the first generation of computers were electronic tubes. In the second generation they were replaced by semiconductors (transistors, diodes, triodes, etc.). In their third generation these were replaced by partly integrated microcircuits while in the fourth by highly integrated microcircuits.

The transition to microelectronics has made it possible to reduce the dimensions of machines and, thus, to increase the frequency of their operation together with corresponding increases in the speed with which each operation is carried out. At the same time, the reliability of machines has been increasing and new perspectives are developing for their reduction in cost since the production of microprocessors may be automated.

Machines of the third generation possess substantially greater capacities of information processing than do machines of preceding generations. By operating with any type of numerical and literal information, they make it possible to process both the alphabetical information that is employed in commercial activities and the numeric information which is applied in science.

The basic structure of computers has also changed in ways that make it possible to simultaneously carry out a large number of operations (to enter information into a machine, to "reallocate" information from device to device, copy information from a magnetic tape or disc for solving other problems through corresponding communications channels and to work with consumers at remote locations). Third-generation computers operate in a multiprogramming mode. This makes it possible to utilize the machine in a time-sharing mode in which contact with the machine is simultaneously established for several users both directly and through intermediate devices such as terminals which may be located at any desired distance from the computer itself and are linked through communications channels.

The coordination of servicing numerous users who are simultaneously engaged in solving different problems is effected through a so-called operational system. This increases substantially the importance of computer software.

The languages employed by third-generation computers have also become substantially more complex. Such lan-

guages as ALGOL-68, PL-1, and SIMULA-67 differ from second-generation languages in their capacity to develop and become more complex. At the same time, the source of the service translator which translates the machine's internal language into the external language remains constant.

There have also been changes in peripheral equipment. In particular new types of peripheral equipment have appeared such as devices for the automatic reading of printed text and terminals equipped with screens. Above all, however, the linkages between machines and their peripheral equipment have been standardized. This makes it possible for any third- or fourth-generation machine to be linked to any peripheral device.

V. M. Glushkov observes that the principal direction of technical progress in the sphere of computers is currently a *systems* approach to their regulation.

Above all this refers to the creation of information data banks on whose magnetic tapes primary data are accumulated and automatically updated. The output of data is effected in the form of blueprints, graphs, project designs, and plans, i.e., in the form of documents ready to be employed in management. Special operational systems carry out sequentially a preparation of data and operating programs on the basis of which an automation of particular processes may then be effected.

It is expected that towards the end of the 1970's third- and fourth-generation computers will make it possible to establish nation-wide information "banks" containing information on different problems of science and technology. New information will be continually added to such "banks" and this will make it possible for scientists, design engineers, and production managers to access information about new scientific and technical ideas on an operational basis.

The choice of equipment for information systems is carried out in a differentiated manner and depends on the tasks that it is expected to solve and the operations that are to be carried out with its help, as well as on the nature of the primary information that is to be processed. It is quite feasible, moreover, and frequently appropriate to

simultaneously employ other information equipment based on perforations techniques.

A classification of types of equipment on the basis of the operations that they are expected to carry out makes it possible to distinguish devices for primary information processing, preparatory information processing, and the main stage in processing. The primary devices include means for recording and transmitting data, the second group includes receivers, as well as editing and formalization devices, while the third includes input devices and devices for storing processed data and for outputting information.

When technical means are chosen in the light of the nature of the task that they are expected to perform, it becomes possible to attenuate subjective continuing propensities towards excessive automation and an excessive attraction to all types of technical achievements at the cost of appropriateness and of economizing considerations.

It is then important to consider both the nature of the problems that are solved by the system and, the technical possibilities of the devices. The application of computers in the processing of information, for example, takes into consideration such basic machine parameters as the following:

- the nature of the elements and blocks employed in the machine;
- memory capacity;
- the speed at which operations are carried out;
- the principle on which work with information is carried out (sequential or parallel);
- the method of displaying information to the user;
- the number of addresses that may be recorded in a single command;
- the types of input and output devices and the speed of their operation;
- the machine dimensions (area and volume required by the machine);
- the rate of energy consumption.

The sphere of applications of computers is continuously growing. It was not long ago that they were employed only for computing operations and served as a type of high-speed calculator. Today, however, they are primarily em-

ployed in order to enter enormous volumes of information into computer memories, to organize their storage and the retrieval of needed knowledge, and to process information in order to create new data banks to be displayed to users. Problems of this type are solved in the most varied fields, including the regulation of the economy, of social and cultural processes, automatic programming, monitoring and diagnostics, processing the results of scientific experiments, the organization of scientific activities, statistics, and the modeling of some of man's logical functions.¹

The increasing role of computers in management is expressed not only in their growing number but also in the creation of new technical and mathematical instruments that are able to carry out individual functions that were previously assigned to persons as well as in the context of decision-taking, organization activities, management, and accounting and control. The procedure under which problems are solved by approximating machine methods to human approaches and methods is also promising. This refers to the methods of heuristic programming. It is true that for the time being the corresponding results are very modest. More generally, the principal trends in the development of technical means for work with information include the following:

an increase in the number of computers and a growing capital investment into computing equipment and software;

a rapid expansion of the sphere of application of computers—computers are increasingly applied to work with social information proper, forecasting and planning, many sectors of production and of services, in government administration and the administration of scientific research and design activities;

a continuous improvement in the quality of computers, which expresses itself in the increases in the size of their "memory" and the rapidity of operations, a reduction in their dimensions and costs, a simplification of interactions

¹ On applications of computers to noncomputing problems see S. S. Lavrov and L. I. Goncharova, *Avtomaticheskaya obrabotka dannykh: khraneniye informatsii v pamyati EVM* (Automatic Data Processing: The Storage of Information in the Memory of Computers), Moscow, 1974.

among machines and users, and a direct translation of human languages into machine languages and back again; an improvement and simplification of software including the preparation of standard programs applying available mathematical methods;

the training of a growing number of computer specialists and especially of operators and programmers;

a growing use of time-sharing methods and real time applications which require an integration of information systems with communication systems;

the automatic allocation of machine time among numerous clients, which permits the fullest possible use of machine capacity as well as an economizing of each client's time, since under "time sharing" and "real time" conditions, clients are able to receive information quickly from a common source and also to exchange information;

a reduction in the cost of collecting, storing, processing and transmitting information made possible by the reduced cost of computers themselves as well as of software and also by a rational allocation and utilization of machine time.

Documentation devices which are employed in the work with information systems are also developing continually. Depending on their purpose, they may be divided into four large groups.

The first refers to the *recording* of information in documents, and the preparation of original versions of documents (pencils, pens, typewriters, stenographic machines, dictaphones, drafting instruments and devices, drafting sets and machines, etc.).

The second refers to equipment for the *duplication* of documents (devices for photocopying, photochemical, microfilm, electrographic copying, thermographic copying, photoelectronic copying, and operational polygraphic devices such as offset, rotary, and hectographic printing).

The third refers to means for *storing* and *grouping* documents (archive and filing card devices).

The fourth refers to equipment for *processing* and *disseminating* documents (numbering devices, stamps, transporting devices, postage stamping and sorting machines, devices for sealing and opening envelopes, etc.).

Software also belongs in this category. It refers to machine programs, mathematical methods and models. A library of programs consists of programs for entering and displaying information, programs governing the work with information blocks, and special programs for information processing.

An overall set of machine programs contains a flow chart representing individual programs and the individual operations contained within each block as well as the initial and terminal addresses of operational memory cells. It regulates the allocation of initial and intermediate information among external recording devices, indicates the code numbers of these devices, the sequences attached to such information, a scheme for allocating input and intermediate information in operational memory, the sequence in which information is entered into the machine and the nature of the carriers employed for that purpose, the priority attaching to its processing by various subsystems of the regulation object, the frequency of information inputs into the machine and information outputs on printing devices, the sequence of information processing, and the methods of control that provide for the reliability of calculations. It also includes instructions for solving the given problem on a computer within which the work of the operator behind the machine's control terminal is specified, as are provisions for emergency interruptions.

Software represents the most labor-intensive component. The preparation of a single program written in machine language requires approximately six man-months of labor. In view of the large number of programs that are employed in information systems it is not difficult to imagine the very great labor intensity of this work. In order to reduce expenditures on the development of software arrangements are currently being established for cooperation in both the writing of programs and their utilization. In addition different proposals are being considered for a multiple attribute classification of programs and of economico-mathematical methods and models.¹

¹ Cf., Yu. I. Chernyak, *Analiz i sintez sistem v ekonomike* (The Analysis and Synthesis of Systems in Economics), Moscow, 1970, p. 112.

The effectiveness of information systems and hence of Automated Management Systems (AMS) depends to a large extent on the selection of programs and on their quality. In this connection, V. M. Glushkov observes that "It is evident that an Automated Management System that operates only with primary information (it supplies only primary information to managerial personnel) ceases to be a regulating system and is of no practical interest. The effectiveness of Automated Management Systems and their power and usefulness depend on the selection of programs that are employed in processing primary information. Their assortment must be sufficiently large and should make possible processing at various levels of complexity. The regulating power of the system increases as does its program library and as its programs make possible a more comprehensive processing of data".¹

Mathematical methods of transforming information are applied whenever the factors that influence the solution of the problem are known and the values of these factors may be established quantitatively. In such cases, linear, nonlinear, and dynamic programming are employed. Whenever full information concerning factors influencing decisions is not available methods of operational research are employed. Probability theory is employed in situations that are associated with large numbers of homogeneous phenomena, each of which may occur in the form of different variants each time, provided that its probability may be expressed in terms of a number. The analysis of information concerning such mass phenomena and processes is carried out with the help of statistical methods.

There exist other methods of information processing as well. They include:

the method of variation analysis in which a number of series of varying indicators are juxtaposed. For example, data concerning time expenditures associated with a parti-

¹ V. M. Glushkov, *Puti razvitiya vychislitelnoi tekhniki i sistem matematicheskogo obespecheniya* (Approaches to the Development of Computer Technology and of Software Systems). In *Avtomatizirovanniye sistemy upravleniya* (Automated Management Systems), Moscow, 1972, p. 177.

cular type of activity that may vary in accordance with the age, sex, and education of the worker;

graphical methods in which tables as well as diagrams and statistical graphs are employed. These methods are especially useful for the study of interdependences in correlation analysis;

correlation methods which are applied to the study of forms of interdependences (of the changes in the average values of a particular attribute that correspond to a number of successive changes in another attribute, and of the stability of that relation which is described by the numerical values of correlation coefficients);

dispersion analysis which makes it possible to calculate the average error of a general average value, instead of individual average errors (averages of each variant).

In cases in which factors are present that cannot be expressed quantitatively logical methods are employed, such as logical proofs and refutations, and especially, heuristic methods, which are based on the creative thinking of the human mind.

Mathematical models are widely employed as a means in information work.

Mathematical models of decisions contain an objective function (a criterion of optimality) and a set of constraints. In the course of selecting a solution that is optimal from the point of view of the given criterion, a solution is found that corresponds to either the greatest value (in maximizing problems) or else, the least value (in minimizing problems) of the objective function. Objective functions may serve as a basis for selecting an optimal solution with the help of a mathematical model, only when they are themselves formalized. As for the constraints they also represent a mathematical formalization of conditions within which a solution is selected.

There exist a wide diversity of mathematical models, including linear models and models of dynamic programming, nonlinear models, integer models, probabilistic and statistical models, models based on the theory of games, network models, simulation models, etc. The diversity of models makes it possible to solve the most diverse regulation problems provided, of course, that they do lend themselves

to a sufficiently rigorous definition and do lend themselves to formalization.

A valuable development concerns the use of models based on signs, and in particular, of models in which information is represented in terms of numbers. Numerical models are represented on digital computers. Their advantages derive from the fact that the input on which they are based (numbers) do not create fundamental constraints on possibilities for modeling and on the range of objects being modeled. This is because the models are based on codes and numbers that do not possess any substantive constraints. Model parameters that are represented in the form of a language of signs, are entered into the computer in the form of an information program representing codes. The universal nature of information modeling explains the universal nature of the informational possibilities of digital computers.

In such a context, however, constraints that currently derive from the inability of formalizing many social phenomena and processes represent a very substantial constraint on modeling with the help of computers. These phenomena and processes are associated with the activity of persons, with their thoughts and feelings, actions and behavior, whose formalization is either impossible or else is possible only to a limited extent.

Norms and normative rules represent still another means for influencing the information in information systems.

The creation of a scientifically grounded normative base is a necessary prerequisite for the design and creation of effective information systems, particularly in the sphere of production.

Normative rules constitute the fundamental information that regulates the production process and places it within a definite context and also defines the optimal quantity and quality of material resources and labor resources that are required for carrying out both a given overall production process and its individual components. If norms and normative rules are not scientifically grounded then they serve as a source of misinformation once they are entered into a computer's memory and provide a distorted picture of production. Consequently they do not increase its

effectiveness and the rationalization of resource utilization.

The normative foundations of information systems include not only norms and normative rules but also the methods through which changes are entered in their values following changes in the object of regulation and the order in which this is done. They also include classifiers of information, methods for standardizing documents, and methods for collecting, storing, processing and retrieving information.

The creation of a normative base for information system avoids a situation in which normative data are contradictory and refer to different attributes. It provides different regulation services with common normative rules and norms for the solution of their information problems, and frees managerial personnel from labor-intensive operations associated with the keeping of all kinds of filing systems thus making it possible for them to devote more time to creative work.

Ultimately, of course, the effectiveness of such systems depends on the individuals who create and apply technical and other means for working with information, on their training, positioning, and attitude towards work.

6. INDICATORS. THE EVALUATION OF OUTCOMES

Information systems must meet certain definite standards. They must correspond to the class of regulating systems that they serve and must possess a structure that is able to provide for its own self-organization, self-regulation, and self-adaptation. Their necessary properties include an appropriate proportionality of the intensity of data processing operations with the speed at which they are entered; consistency in carrying out a specified sequence of operations and procedures for transforming information within each of its elements; an integrative aspect that makes it possible to transform information in complex manners; stability in the sense that such a system is able to accept both internal and external perturbances, without changing its own structure; and selectivity in the sense of a capacity to respond to the type of information that is needed for a given regulation process.

Indicators that describe the work of a system include the following:

- its productivity (minimal total expenditures of time transforming a given volume of information and establishing its reliability);

- its throughput capacity (the capacity of a system to process information in forms that are convenient for decision-taking: the number of literal and numerical signs per hour);

- its computational capacity (the total number of operations per hour);

- its speed of operation (the quantity of information that is processed during one hour);

- its capacity (the quantity of information circulating within a system per unit of time);

- the cost of a unit of information (primary and derived);

- the level of automation of the information transformation process both in subsystems and for the system as a whole; system's repayment time.

The values of these indicators depend on the systems' structure, the scheme governing the technological transformation of information, the composition of the system, the speed of operation and stability of its components and the degree of automation of information processing, as well as other factors.

Their *economic effectiveness* is the most important measure of information systems. Frequently it is determined through a comparison of benefits with expenditures. In such cases it is often forgotten that information systems produce substantial improvements in productive and managerial activities even in those cases when their introduction does not reduce the direct managerial expenditures.

In estimating the economic effectiveness of information systems it is necessary to recognize that each outcome of labor's activities and each useful thing may be seen from two points of view, namely, from the point of view of quality and from the point of view of the quantity of labor expenditures that it requires.¹ In the case of information work the quantitative aspect is expressed in terms of the relation of the user to the information that is produced,

¹ Cf., K. Marx, *Capital*, Vol. I, p. 43.

since it is designed to be useful to him. An evaluation of the outcome of information work from such a point of view does not depend on the specific quantity of labor that has been expended on obtaining information but is considered only from the point of view of the usefulness of the resulting effect. That effect is primarily determined by two indicators: the extent to which specified objectives have been met and the extent to which the use of information systems is convenient.

A lack of correspondence with objectives is produced either by an excessive abundance of information, or else an insufficiency of information.

Redundant information makes it impossible for the user to employ the knowledge that he receives in the particular form in which it is presented. Before he can employ this information he finds it necessary to process it once again and to carry out one more cycle of information work. It is possible to reduce the volume of information to that minimum which is required by an optimal regulation in a number of ways. These include the aggregation of indicators and a consideration of admissible deviations from specified parameters.

Insufficient information causes clients to turn to other sources and essentially to organize a new information system that he would find adequate. In order to define the needed measure of comprehensiveness of information it is necessary to define with precision the sphere of competence of clients and the range of their interests as well as the type of managerial problems that they are seeking to solve.

It is possible to estimate the degree of economy derived from information systems through a consideration of the outcome of information work from a quantitative point of view, i.e., from the point of view of corresponding expenditures of social labor. An analysis of production expenditures and of revenues received makes it possible to judge the profitability or else the losses attaching to its utilization. It is generally considered that the economy derived from an information system is expressed concisely in terms of the costs of production per unit of information that is processed and also the influence that the work has on the outcome of the enterprise's production activities (on its costs

of production, its profit, etc.). In evaluating an information system, however, it is also important to know to what particular factors such economies may be attributed.

These factors include a capacity to solve new problems that could not be solved earlier with the help of traditional methods, further improvements in the technology of information work, the orderly organization of primary information, and applications of modern technical means and of mathematical and information software.

In short, the economic effectiveness of information systems is measured not only in terms of a high quality of the resulting information or else of lower expenditures on its production, but in terms of both. A due consideration of this fact at the stage of preliminary designs and design calculations will increase the extent to which the creation of information systems is economically justified.

In automating information processes, increases in the effectiveness of individual subunits should not reduce it in others, and the objectives of such specific objects as enterprises, for example, should basically coincide with those of society. If their automation does correspond to the interests of society but does not accord with the interests of the given system the workers of the corresponding collective will not be interested in automating the regulation structure. Similarly in the reverse case society as a whole will not benefit from it.

It should be noted that at the present time there still do not exist any fully satisfactory methods for evaluating the effectiveness of automated information systems. As a rule existing methods tend to overestimate the resulting effect by ascribing the results of many other positive changes in production to the new system. Accordingly ways should be found to identify and estimate the "net effect" of information systems.

The factors that determine the forms, methods, and rates of automation systems include the level of development of science and technology, the specific properties of the given object, the existence of corresponding experience and personnel, and the availability of needed devices, and equipment as well as of material and financial resources. Each of these factors emerges and develops at different times

and within different subunits of the social organism. Accordingly, automation should be approached concretely and the methods, means and rates through which it is to be carried out should be analyzed in specific terms. In some cases a rapid introduction of automation will be effective, while in others it is more appropriate to spread it out over time and introduce it in stages as the necessary conditions emerge.

The effectiveness of information systems is intimately associated with such attributes as their *reliability* and *flexibility*. Only a reliable regulation system, which is able to withstand the perturbing influences that it continually experiences, can be effective. Reliability is achieved through the use of high quality equipment, a high level of training of the specialists who employ it, and a precise organization of their labor activities and interactions with each other as well as discipline and sense of responsibility for the tasks that are assigned.

The following may serve as criteria of reliability: the length of service of devices and of the system as a whole; the probability of its uninterrupted operation within a given time interval; the acceptable limit of unreliability of information being processed and of technical resources as measured by the sum of the time intervals of uninterrupted operation. The problem of reliability is becoming increasingly acute because the growing complexity of information systems tends to reduce it.

The reliability of information systems may be increased through the use of reserve duplicating devices in processing information, of special devices for identifying and correcting errors, and of effective methods of control designed to avoid losses of information.

Systems' reliability may also be achieved by designing it in terms of an hierarchical structure in which the number of levels depends on both the character of the object of regulation and the degree of its complexity. In such case, each level is relatively autonomous. It identifies the tasks and objectives of the level below on the basis of objectives that are identified by the higher levels. Disruptions in the operation of one such level do not produce a disorganization of the entire system, since its functions are

then taken over by the next higher level. In addition each level is also able to operate autonomously for a certain time.

The degree of automation increases at lower regulation levels. It is possible to automate fully the management of a production shop and of an enterprise. But at higher levels of management, the role of automatic devices declines and that of man is correspondingly increased. This is because the role of specifically social factors increases whose monitoring and regulation does not lend itself to automation.

Past experience has shown that those mixed centralized systems are most reliable and effective in which the entry of primary data is decentralized (so that it is possible to increase both the rate at which the system accepts external information and its volume and diversity) while the storage and processing of information is centralized. This makes it possible for managerial personnel to encompass the functioning of the overall system, to search and acquire the needed data rapidly, to process it in accordance with a unified methodology, and to integrate and standardize information.

A system that is reliable is also one that is flexible, while the factors that enhance reliability are also those that provide for flexibility. The parameters that describe a system and its environment are continually changing and the problem is thus to identify these changes in time and to respond accordingly. At the present time self-teaching management systems are being developed intensively that are able to take past experience into account as well as data describing changes in the current situation. Similarly, self-organizing systems are being studied that are able to restructure themselves in responding to external and internal perturbances in such a way as to optimize their own structure and their own program as well as their behavior. Such systems are still at the stage of development. The corresponding central problem concerns providing their regulating bodies in time with information pertaining to all issues that require decisions. If the desired effect is to be achieved the corresponding principles must then be applied at all levels of regulation from that of the shop foreman to that of the manager.

It is the *outcome* of a system's functioning that serves as the principal factor in integrating it and providing for its effectiveness and reliability. For only information feedback from such outcomes is able to produce signals concerning the system's deviations from programmed objectives and specified parameters.

The programmed outcome and the actual outcome operate as two interdependent normative factors that govern the system. More specifically the first serves as the objective towards which the course of the system is directed, while the second serves as a landmark and a stage on a path leading to the specified objective. The difference in values provides an indicator of the system's deviation from the specified objective. This will be perceived by the regulation subsystem and subsequently serve as a motivation for initiating regulation activities aimed at overcoming prevailing deviations.

* * *

In defining the most general trends in the development of automated information systems for the next 10 to 15 years one may expect an increasing orientation of such systems on the information needs of decision-taking, an increase in their influence on regulation processes and systems, an increasing orientation on systems approaches, a growing complexity and range on the part of the systems themselves, and an increasing capacity to encompass wider sectors and entire spheres of social life in terms of complex structures.

7. IS SOCIAL CYBERNETICS FEASIBLE?

The theoretical foundations of Marxism-Leninism and achievements of regulation science and of information theory as well as of the material basis provided by modern technology suggest that the possibility now exists that social cybernetics will emerge as a specific science whose object is to study the quantitative, formal-logical and technical aspects of work with social information.

Let us recall that cybernetics studies information invariants of primarily technical systems. Partly successful at-

tempts are being made to apply the cybernetic approach to biological systems. As for social systems cybernetic studies have been limited to studies of the quantity of information that may be stored, processed, and transmitted along channels of communication. This refers, moreover, to primarily scientific and technical and especially economic information.

Generally, economic information lends itself much more readily to quantitative measurement and hence to mathematical processing. It lends itself to coding and recording on different carriers and to decoding and processing, to storage and retrieval as well as communication over any desired distance. It may be reproduced and aggregated, and possesses properties of discreteness. It is also cyclical in nature and refers to very large numbers of processes. The extent to which mathematical methods may be applied to other types of social information is still limited.

Is it possible to envisage a wide and integrated cybernetic approach to society and to the large subsystems that it contains? In our opinion this is possible.

Societies are homeostatic, adaptive systems. Since information processes play a large role in their life and development and especially in regulation activities, informational cybernetic invariant (model) of society is possible. The principal problem, however, concerns the nature of the laws of behavior, the cybernetic principles that govern social systems, the extent to which they make possible the study of societies, the aspects that can then be studied, and the nature of the constraints that societies themselves place on the application of cybernetic principles.

An interesting attempt at a cybernetic analysis of society and of social information has been undertaken by V. I. Chernysh. In viewing society in terms of a systems approach, he bases his approach "above all on a specific dynamic consideration of a diversity of mechanical cybernetic, physical-chemical, and biological factors that constitute the elementary material basis of social phenomena".¹ He views society as a very large thermodynamic

¹ V. I. Chernysh, *Informatsionnye protsessy v obshchestve* (Information Processes in Society), pp. 6-7.

system within which exchanges of energy take place both among the subsystems that compose it and with its environment. This refers, moreover, to a self-organizing thermodynamic system, that is to a system possessing a capacity for maintaining its internal structure at a given level or else improving it. The system possesses such a capacity through the operation of regulation constraints, that is the set of physical and chemical constraints that maintain entropy at a constant level or else reduce it. Processes that lead to the defining of regulation constraints are interpreted as regulation processes. Regulation is associated with a recording of relationships or else an auxiliary restructuring or else of an additional ordering of the regulation object. As for processes that monitor, identify and record properties, i.e., permanent and changing relations as well as the organization of the overall set of constraints they are information processes.

Because it is a basic attribute of regulation activities, information operates symbolically in changing the properties, structure, and functions of the system.

B. B. Melik-Shakhnazaryan is the author of an original attempt to apply a cybernetic information approach to problems of social regulation.¹

In particular, the author formulates a number of laws governing the "cybernetics of society", namely:

- the law of growing information within a system;
- the continual increase in the quantity of information within any optimized homeostatic system as a result of the law of the growth of information;
- the need to create within regulation systems data blocks representing permanent information and relationships that reflect the material state of a given system as a basis for its existence in an optimal state;
- the law of feedback relations;
- the law of optimal regulation, which is a process that provides for a maximum growth of information within all positive sets of the social regulation system;

¹ Cf., B. B. Melik-Shakhnazaryan, *Kibernetika obshchestva* (The Cybernetics of Society). In *Vestnik obshchestvennykh nauk* (Bulletin of Social Sciences), Erevan, 1970, No. 12, pp. 49-62.

the law of direct relations; in all situations in which a transformation and immediate dissemination of information is not required or not appropriate it must be transmitted directly to interacting objects.

It may be seen that B. B. Melik-Shakhnazaryan views the "cybernetics of society" as a set of laws governing the accumulation, transmission, and utilization of information. One may question the number of these laws and the exact formulation of each of them, but the idea itself of an information approach to society does not raise any doubts.

Another author who studies the developments of social cybernetics is M. Bagrad, who defines social cybernetics as the *science concerned with laws governing purposeful activities relating to an optimal transformation of society as a complex dynamic system on the basis of an expanded reproduction of information and its exchange in accordance with the principle of feedback relations between subjects of regulation and objects of regulation with the help of computers*.¹

It seems to us that this definition is excessively wide, since the laws governing purposeful activity in accordance with an optimal transformation of society are being studied by historical materialism and Marxist sociology (the more general laws) and the theory of social regulation (this refers to specific applied laws).

As for theoretical cybernetics it represents a mathematical and formal-logical science that studies those laws of regulation in living nature and society and technology that do lend themselves to formalization. In such a context social cybernetics may be formalized only as a science studying the laws governing the regulation of society (purposeful operations on society) from a quantitative and formal-logical point of view. This is precisely the reason why social cybernetics cannot be a comprehensive science concerning the regulation of society, since to a very large extent the latter is associated with non-formalizable phenomena and processes.

¹ M. Bagrad, *Nauchnoye upravleniye obshchestvom v aspekte klassifikatsii ego strukturnykh elementov* (The Scientific Regulation of Society from the Point of View of a Classification of Its Structural Elements), Riga, 1973, p. 7.

Most probably social cybernetics encompasses the set of problems that concern the *quantitative aspects of the qualitative contents of social information*, and the set of methodological and technical means for its collection, processing, and storing and utilization, including the specific mathematical framework and "assortment" of linguistic means able to adequately reflect the specific quantitative parameters of social systems at various levels that are important for purposes of regulation.

This refers, moreover, to a science whose theory is a generalization of information processes taking place both in socialist and in bourgeois societies. Before such a general theory can be created and before specific aspects of social information can be formalized a number of difficulties remain to be overcome. Among these the most important are about the absence of mathematical and formal-logical means able to reflect the qualitative contents of social processes with sufficient accuracy and in the form of quantitative indicators.

Nor should it be forgotten and this is very important, that the contents (meaning and value) of social information possess a clearly expressed *class orientation*. It has already been noted that this calls for a Party objectives-oriented and class-oriented analysis of social information.

It is well known that the theoretical basis of a scientific regulation of society is provided by Marxism-Leninism and the entire range of social sciences, which offer primarily a qualitative representation of social processes. In carrying out qualitative studies of a society and in processing the corresponding results social sciences serve as a basis for the identification of the "behavior" of social systems as a whole and of their concrete subunits, as well as the laws of behavior that govern the corresponding trends. This makes it possible to regulate social processes in a socialist society and to forecast their course over specific time horizons.

The problem that is now defined refers to the carrying out of a quantitative analysis that will substantially supplement and add to a qualitative analysis and that will provide a precise quantitative basis for scientific regulation activities. Academician V. S. Nemchinov has observed

that "by analyzing our historical experience it is possible to show that Marx's and Lenin's qualitative forecast has served as a leading landmark and is now carried out and embodied in the socialist system. At the present time the socialist system requires one more supplementary quality, namely precision in the quantitative guidelines for the regulation of the economy".¹ For our part we would add this: not only the economy, but all other societal processes, and specifically social and spiritual ones.

Social systems are exceptionally complex and this manifests itself in the fact that within each system a very large number of elements interact that may find themselves in the most diverse states, each described by a variable. These variables may be expressed as vectors, scalars, matrices, and logical or mathematical functions as well as in the form of frequency distributions.

These elements and element states and the corresponding variables are characterized by great variability while the range of their variation is unequal even though its average value is small. It should be added that the diversity of the relations among objects and in their states is such that as the latter vary, the number of variables expressing the state of the overall system increases enormously.

All the factors that are expressed in terms of variables are interdependent, and there exist a very large number of correlations and dependences among them which contain relations of coordination and subordination as well as genetic relations, in which a given factor, a determining one, creates another one, which is determined. In view of the nonlinear character of causal relations in social objects, moreover, it is often quite difficult to identify the determining factor (or corresponding groups of factors) and the measure that indicates the extent to which each factor influences the others within the system as a whole. In short it is quite difficult to carry out a measurement or else a joint measurement of the operation of factors. This is because of the differences in their nature, in their intensity, and the characters of relations among them.

¹ V. S. Nemchinov, "Ekonomicheskaya informatsiya" (Economic Information). In: *Sistemy ekonomicheskoi informatsii* (Economic Information Systems), Moscow, 1967, p. 10.

All components in social systems, as well as their states, processes, relations, are associated with the affairs and activities of individuals and particularly the relations among are mutual only at an aggregated level, and which reflect integrative aspects as well as conditions in general trends and social laws. This produces a certain indeterminacy in the course of social processes. At the same time the activities of individuals and particularly the relations among them and their thoughts cannot be represented either on numerical or else on ordinal scales. It should also be added that specifically human methods of perception and of utilizing information (filtration and evaluation, the selection of alternatives, the nonunique correspondence of searching procedures, associativity and the utilization of models and numerical forms as well as of simple counting forms) do not lend themselves to precise quantitative descriptions.

In such circumstances it is especially important to clearly formulate the task that the given subject of regulation is expected to carry out. Only a precise unambiguous specification of the problem will make it possible to select from a frequently very large volume of information those variables that bear the relation to the task that has been specified and that are necessary and sufficient for its solution. The values of these selected variables, taken together, constitute that specific information that is necessary for regulation or, to be more specific, for a given regulation activity.

This is the way in which a system of quantitative indicators of social life has developed without which the functioning of society itself is not possible, particularly of contemporary societies. Societies cannot normally function and develop without verifying and controlling themselves and without expressing the results of their activities in the precise and accurate language of numbers and the language of mathematics. Thus in the course of the development of society and of labor and communications among persons there emerged the first social information systems, which with varying measures of accuracy reflected in mathematical quantities the state of society and the outcome of the activities of individuals in different spheres, particularly in the economic sphere. Book-keeping and the methods of

double-entry book-keeping had already developed in medieval society. Subsequently statistical and demographic information systems developed that reflected different aspects of the functioning of societies. In particular one of the most important types of social information, namely economic information, has developed very intensively. And this is not surprising, for economic and production activities continue to serve as the foundation of social life. Social life is impossible without production, distribution and consumption, the organization of which necessarily requires the creation of a system of accounting and control and of a system of economic information.

As production develops technical and technological information acquires increasing importance. This refers to systems of technical blueprints, technological maps, different types of norms and design information employed in construction activities. At the same time a system of social information (in the narrow sense of that word) is also developing that contains data concerning quantitative parameters of different social communities, classes, associations, collectives and groups.

Whether or not social cybernetics will emerge as a specific science is a matter for the distant future. In the meantime it is already necessary now to solve a large number of practical questions in the sphere of regulation that call for the urgent development of principles, methods, and means of organizing integrated systems of social information needed for the resolution of social processes in socialist societies. Above all it is important to define the volume and content of information, and the criteria and means of its optimization. It is necessary to develop effective methods and means for receiving and processing data of a social character and for measuring the quantity of information that is contained in social documents.

It is this which represents the prerequisite that is necessary for practical recommendations which refer to the selection of effective means of communication, documents, carriers of information, sign systems and languages, machines and devices and rational systems of norms.

It might appear at first that from the practical point of view this task cannot be realized. A socialist society includes

a very large number of social objects, each of which is highly specific and individual in many respects. Yet the solution of such a problem is made simpler by the fact that the entire set of social objects may be classified on the basis of common structural and functional characteristics. Indeed, there is much that is common and similar in such objects as society's subdivisions into Union republics, Autonomous republics, territories, regions, districts, cities, and rural communities. There is also much in common in the objects of sectoral divisions, ministries, committees, production and other associations, enterprises, and organizations.

It therefore seems to us that the initial step in creating a theory of social cybernetics calls for a scientific classification of social objects and an identification of different types, classes and basic traits and parameters of such objects; as well as a search for the quantitative values of those parameters that are necessary for regulation. The creation of standardized information systems will make it possible to develop standardized regulation systems that correspond to these objects and to bring them into operation in ways that will take into consideration specific individual traits of the corresponding objects. In short we are referring to the creation of an interrelated system of social models and algorithms of standardized regulation systems that will make it possible to organize the effective functioning and development of different subunits within the social organism on the basis of the most modern technical equipment.

At a time when the organization of information processes is increasingly based on computer technology one of the important and difficult problems is to embody social information into forms that are convenient for processing with the help of computers.

Yet only the very first steps have been taken in developing the specific mathematical framework that is useful for processing social information.

Social information is embodied in specific texts, which may in principle be reduced to a common language that lends itself to formalization. A possible approach to such a formalization is an analysis of texts in which the diver-

sity of the latter is reduced to a specific assortment of substantive elements whose values are then calculated with the use of computers. The most difficult step in such an operation is defining the substantive elements that may serve as a counting unit. These will apparently vary depending on the information content and nature of the problem for whose solution it will be employed.

At the present time this difficulty is being overcome through the use of available methods and mathematical conceptions. In order to forecast flows of social information, the methods of mathematical statistics are employed. To measure information for purposes of regulation in a context in which regulation tasks are precisely defined in terms of a homogeneous language the theory of games and the theory of teaching automata is employed. In cases in which problems are complex and the languages differ (quantitative scales, ordinal scales, nominative scales, an absence of scales) decisions are taken with the help of methods of pattern recognition. In retrieving required information from very large data blocks under conditions in which the throughout capacity of channels is constrained the theory of queues is employed in order to avoid a loss of information. In solving problems relating to the transmission of information along channels of communication and to their computer processing C. Shannon's classical theory of information is employed. Additional examples may be noted. In order to study problems of information languages the theory of mathematical linguistics and structural-typological analysis are employed. To design data processing systems monitoring theory is employed.

In addition to a utilization of the mathematical framework that already exists, a new specific framework is gradually being developed that represents a collection of equations, graphs, matrices, and models that make it possible to express the quantitative aspects of social events more accurately.

The development of programs that define the transformation of internal and external information as well as the transmission of internal and external commands plays a large role in the processing and utilization of information.

The types of such programs are quite diverse. They include pattern recognition, searching, grouping, ranking, aggregation, disaggregation, defining dimensionalities and translating into different dimensionalities, the specification of addresses and transmission of information, the creation of models and their solutions, and the complex processing of data. This refers, in short, to the development of a system of both general and specific programs.

Social information serves all types of social regulation as well as all units and levels of regulation. The corresponding requirements can be met by complex information rather than by a particular type of social information. It follows that it is important to organize systems of collection and processing of information in such a way that they may be applied to a complex processing of the entire assortment of its indicators. Today matrix models of social information are being developed that limit its comprehensive utilization and do not make it possible to apply it at different levels of regulation and to solve different types of problems. A linkage of quantitative indicators describing different aspects of social objects may be assisted by multiple factor models whose development today is at an early stage. The creation of such models will make it possible to increase the effectiveness of the utilization of information substantially as well as to reduce the time that will be required for its retrieval and processing.

The mathematical modeling of regulation processes makes it possible to solve problems relating to the optimization of the dimensions and structures of regulated and regulating systems, to modes of operation and critical values of their basic parameters, as well as problems relating to information processes. Modeling makes it possible to develop different variants of regulation systems and to compare them in order to select the best. In short, when based on a reliable system of social information, mathematical modeling is an important means for improving regulation systems.

It should be noted that today mathematics is developing confidently into directions that make it possible to meet the needs of sociology and of social regulation. Important changes have taken place within mathematics in recent

decades. Nearly all applied areas have experienced the influence of probability theory, whose role in contemporary mathematics has grown enormously. New branches of mathematics have developed, including the theory of operations research, mathematical logic, mathematical programming, functional analysis, the theory of graphs, optimal control theory, and abstract automata. This has certainly increased substantially the possibilities of mathematical methods in sociology and in the analysis of social information.

The *qualitative* analysis of social information provides a basis for applying quantitative methods of analysis. For it is the identification of the contents of information and of its purpose and usefulness that makes it possible to define the sphere of application of these methods and their effectiveness in solving regulation problems. The application of quantitative methods then makes it possible to arrive at new conclusions.

The specific importance of quantitative methods derives from the fact that they make it possible to define the optimal information (the measure of the degree to which it is necessary and sufficient) for solving particular problems. This refers, of course, to a rigorously mathematical optimum that is best for the given conditions and constraints.

A diversity of specialists participate in information work who communicate with each other in different scientific languages. Since mathematical conceptions possess unique meanings, mathematics serves as a common language for different specialists working with information.

Let us emphasize once more that a quantitative analysis of information yields positive results only after its qualitative aspects have been identified. Quantitative methods alone will not identify the essence of the social processes that are reflected in information. Only a substantive sociological Marxist-Leninist analysis makes it possible to identify the class and social nature of phenomena. Such an analysis makes possible a scientific approach to the *selection* of information that is to be subjected to the corresponding quantitative processing. An unscientific selection that is not based on theoretical grounds associated with

epistemology will inevitably produce a situation in which the selected information will be useless for regulation activities even if the most modern mathematical means are employed in processing it. In working with social information the most important task is to express the *social nature* of phenomena, and this presupposes a scientific view of the world on the part of the researcher that is guided by dialectical materialism.

CHAPTER VIII

INFORMATION, MAN, AND COMPUTERS

The outcome of design activities in the creation of automated information systems largely depends on a correct definition of the respective roles of individuals and of computers and of their rational interaction within a "man-computer" system. Let us examine that system and compare the capacities of man and of machines in working with information.

1. MAN AS THE CENTRAL LINK IN "MAN-COMPUTER" SYSTEMS

Computerization is an essential factor in the socio-economic, technical, and spiritual progress of mankind. The introduction of computers into all spheres of human activity is taking place on an increasingly comprehensive scale. Today computers are not only a powerful computational instrument and a means of storing and processing very large volumes of information, but also a means for assisting the intellectual activities of man. Under the influence of computers changes are taking place in the structures of thought processes, in the organization of physical and intellectual labor, and in the sphere of knowledge and education and the spiritual world of man.

"Man-computer" systems have emerged in the course of computerization. They represent a powerful instrument of learning and of obtaining and processing information. In

their most well-delineated and promising form they have emerged in connection with the third generation of computers which are able to simulate a relatively wide range of logical operations that are characteristic of the human mind. At the present time intensive studies are taking place of man's interaction with machines within such a context. This is accompanied by lively discussions concerning the respective role of each.

G. L. Smolyan notes three aspects of man's interactions with computers.

First, the socio-economic aspect of development and introduction of man-machine systems and complexes; this is a problem of the social effectiveness of computerization.

Second, an optimization of the functions of man and computers, an engineering and psychological servicing of the system and an analysis of the psychological factors attaching to the new phase in the automation of intellectual activities.

Third, a theoretical cognitive aspect of the integral nature of man-machine intellects and of associated problems, relating both to human and machine (artificial) intelligence.

We will consider only one question, namely, the interaction of man with computers in work with information.

"Man-computer" systems constitute integrated systems whose properties are more than a simple sum of the properties of its components. They are able to solve problems that neither man alone nor machines taken alone can solve. When amplified by the machine brain man's creativity rises to new levels because man is freed from the carrying out of routine operations and is able to verify particular hypotheses through experiments in the course of solving regulation and other problems and also to enter adjustments in the course of his own thinking and behavior.

The functions of the human operator within a "man-computer" system may vary. Man may appear in the role of a receiver of information originating from the object of regulation (the machine) and as its retranslator, who transmits information from one unit within the system to another. He may also carry out an analysis of information and take decisions, i.e., develop regulating or command information. Man may also carry out the programming function for the

operation of the entire system or of its components, i.e., develop programming information. On the basis of information being conveyed from the object he may carry out control activities over the system's operation. Finally, he may carry out regulation commands, that is, carry out activities that are directed at the transformation of the objects in order to bring about their movement towards their specified objective. Usually, man combines all or some of these functions and executes them either simultaneously or sequentially.

It should be emphasized that even the most surprising types of progress in electronic and computing technology cannot reduce the role of man. He will always remain the central link in "man-computer" systems, no matter what the improvements in the computer may be. It is man who creates machines. And it is he who assigns programs to machines and controls and guides the course of their execution. It is man who evaluates the available alternative activities and selects the best among them. And it is man who assigns the force of legal power to decisions.

Information is processed at the most diverse levels and in the most diverse ways. Yet ultimately, all work with information is oriented either on responsible person or else on the body taking decisions. It is on man that the entire responsibility for decisions that are taken falls. That responsibility cannot be transferred to the machine. It is precisely man who takes decisions and who considers the multiplicity of political, socio-economic, socio-psychological and other factors that influence the system. These factors cannot be formalized and hence cannot be taken into consideration by machines.

The relation of man to computers will always continue to be a relation between a "subject of labor and an instrument of labor" in which computers, like men carry out different functions. In one case, machines perform an information display function: they provide to man the information that he requires. In the second, they generate information containing recommendations: they offer different alternative solutions to man from which he then selects the best. In the third, computers assume a part of the regulation functions, leaving another part to man. In still other cases computers

carry out all functions bearing on regulation (this refers above all to the regulation of technological processes), while man carries out functions of control over the computer. In all cases the central element in the interaction between man and computers is an *information interaction*. Information received by man from computers, information models of the situation serve as a basis for the development of regulation activities.

Man's regulation capacities are based on his capacity for modeling, for reproducing in his consciousness both regulation objects and the complex system of components and interactions that they contain. It follows that the automation of regulation processes essentially reduces to the creation of automatic mechanisms that could construct operational information models of regulation objects. Automata that make it possible to model the entire range of intellectual and physical processes of regulation that are carried out by man, do not exist, and accordingly the issue concerning which of these operations may be assigned to machines (given the present level of automation capacities) and which must remain the responsibility of operators or dispatchers is one that has not been solved.

It is not possible to solve that problem without careful and comprehensive, psychological and social analysis of the capacities and experience of man that he applies to solving regulation problems. For man is both an intellectual and social being, and beyond this, the intellectual element in man is itself a product of his social and historical experience, particularly in the sphere of production activities, which are by their very nature social. The systems and complex approach that is characteristic of man and his capacity to perceive actual existing systems and to create new ones from the most diverse elements may initially seem to be unrelated to each other. Yet it has resulted from his social, and more specifically, his socio-systemic life and activity. It is precisely such a capacity to combine and systematize different elements and fragments of past experience derived from earlier generations as well as from personal experience, and to mobilize and concentrate that experience for solving a multiplicity of highly diverse problem situations that makes it possible for man to solve complex regulation

problems. But it is then precisely the re-creation of such a capacity and its simulation and modeling on computers or other automated devices that constitutes the principal difficulty in automating regulation activities even though in principle that difficulty can apparently be surmounted since it may be expected that new and currently unknown methods for formalizing man's intellectual activities will become available including the formalization of his regulation activities.

One of the important conditions for the functioning of Automated Management Systems is to achieve a correspondence between the physical and intellectual capacities of man and the objectives that are assigned to the system and are solved with the help of automatic equipment. But this is only one aspect of the matter. Socialist societies are equally interested in the capacity of automated systems to widen the creative capacities of man, to contribute to his cultural and technical development, and to create the most favorable conditions for the fullest possible expression and development of his capacities.

Under traditional nonautomated modes of regulating technology (a lathe or some other means of labor) as well as of technological processes interactions between man and machines remain unmediated. Such interactions, moreover, are of a dual character. There is first a physical interaction in which with the help of his hands and sometimes with his legs the worker regulates the course of the production process by carrying out operations that are defined by the corresponding technology. But there is also an *informational* interaction in which the worker visually monitors the process that is taking place, identifies its course, and processes and utilizes information that he receives directly as a result of labor activities. Between the laborer and the machine, there is then no informational mediator or mechanism that models the forces of production processes by receiving and processing information needed for the regulating activities bearing on the machine.

A different situation exists in the case of automated production activities where equipment and technology is regulated automatically. Systems of this type replace man in direct production activities, that is, in his direct operations

with means and objects of labor. Such systems already contain three components, namely, "man-automatic device—working machine (technological process)". A direct physical interaction between man and working machines is excluded in such cases, while information interactions are mediated through computers. An analysis of individual operations associated with the given technological processes makes it possible to formalize the operations that are carried out by the means of labor, and to assign their execution to the computer. Man then interacts directly with the automating device that receives, processes and displays to him information in the form of a model. The informational interaction between man and computers may be reduced to an analysis by man of the model produced by the automatic device, and an adjustment of the corresponding operations by the automatic device on the means of labor (technological process). There is also a physical interaction between man and the automatic device which reduces to a manipulation of the automatic device's regulating instruments.

In his capacities as an operator of an automated system man works in a "dual" world. One is the real world, that of sensory perceptions within which he has grown and lives. The other is the world of symbols, codes, and signs within which he works. He does not feel directly the particular objects that he is regulating; they may be far from him or else, dangerous in terms of direct contact. At each moment in time he judges the state of the regulated object in terms of displays of instruments and in terms of conventional signals that he receives from these objects. His responsibility and his emotions are quite real, but their sources are not the real objects that he is regulating but rather certain symbolic informational models of these objects. And even though that model may reflect the state of the object adequately, the operator's activities do not always correspond to the needs for the object's optimal functioning and to standards of operational action and precision. Studies have shown that from 20 to 53 per cent of failures in regulation systems are associated with errors in the work of human operators.

This situation is still more complex in the case of a second class of automated management systems. This refers

to automated administrative systems such as those that exist in modern large enterprises, whose collectives number many thousands of persons. It also refers to production sectors. The ultimate objective of such Automated Management Systems (AMS) is to optimize the management of production activities. This includes as subsystems, systems of the "man-automatic device-operating machine" type, or else of the "man-operating machine" type, within which man's interaction with technical equipment is carried out in the manner that has been described above. Within such administrative Automated Management Systems, the systems of the first type, which serve the management of production processes, are combined within a specific hierarchy of systems: brigades (working station), production shops, enterprises, and production associations, each of which is regulated by a regulation subject (subsystem) headed by a responsible official. These subsystems are linked by information-logical and organizational and technical ties and carry out activities in the field of planning, the organization of production, accounting and control over the course of production, material and technical supplies, and output deliveries, as well as other functions. The functions of collecting, storing and processing information are automated at a level of the system taken as a whole. Appropriate displays of information forms are made available to regulating subsystems and to responsible persons, who employ it in making decisions and in carrying out organizational measures and control measures over the executions of decisions, once more with the help of automated means.

Intellectual functions as well as functions of accepting, storing and processing information play an increasing role in automated production, particularly with the appearance of cybernetic machines and devices. Even though the range of intellectual problems that are solved by computers is continually increasing at the present stage of their development and this will apparently continue in the foreseeable future, they will continue to solve only partial regulation problems. To integrate these partial problems into a single whole and to link individual components and processes of regulation into an overall system is a task that can be carried out only by human operators. As a universal receiver,

storer, and processor of information, and as its only user man serves as the principal integrating component in regulation systems. The advantages of man over computers in work with information are both substantial and apparent.

There is no doubt that man possesses a much greater flexibility and reliability in receiving, processing and using information. In particular, the capacities of man in accepting information are especially important, since the capacities of his "sensor input" are not limited by any single mode of accepting signals. Man is able to receive the most diverse signals such as light, sound, which change in form, intensity, and periodicity within the widest ranges. He is able to receive information in the form of both direct signals that are addressed to him, and signals that are indirect and that accompany other processes and are not foreseen by the regulation scheme itself, and is able to synthesize different signals into integrated systems, some of which may be stochastic and possess a small probability within a given situation.

As for computers, their possibilities for perceiving information are limited by their construction and the rigid scheme to which they conform. They receive only those signals that are addressed to them and do this, moreover, in the context of forms that are once again defined by their construction.

Similarly, the advantages of man in the processing of information are very substantial. In fact man's capacities in this respect are truly boundless. Man uses different means for processing information, and for its coding and decoding, and passes relatively quickly and relatively simply from one method to another. Human operators also exceed machines in the execution of informational commands and in their ability to carry out control and other regulative processes. They are able to change programs and regulate the most diverse processes, passing from one system of regulation to others. Computers, on the other hand, are only able to carry out rigorously defined and inevitably specialized commands and functions of regulation and control.

Man's thought processes work with information in ways that are more economic and rational than do machines. In solving a problem in chess involving three figures, for example (king, bishop, and knight), the machine must examine

sequentially a number of variants that is equal to the number of atoms in our galaxy. A skilled chess player, on the other hand, will simply analyze a small number of variants.

Man's memory and experience, which are recorded in the information that is stored in his brain, is far more flexible, many-sided and mobile than in the case of machines. That information is not erased as may occur in the case of information recorded on punched tape, or on magnetic card of computers. In some cases it is stored over very many years in unsuspected recesses of the human brain without any seeming use. But suddenly, in an unexpected situation in which decisions to solve a problem cannot be postponed, it surfaces from the brain's labyrinths and helps in solving a practical problem. We do not even mention intuition and the emotional coloring of information which are altogether unavailable to machines.

Man's memory stores enormous volumes of the most diverse information, while the quantity and nature of that information depend on the level of education and on the nature of the profession and of the professional training of the person, as well as on his hereditary gifts and psychological qualities, and many other factors.

There exist several types of memory. One of them is a static memory in which man occasionally stores very large volumes of diverse and largely fragmented knowledge that he is ready to provide at any moment. Persons who possess a static type of memory may develop into persons who are skilled in documentation, but it is by no means frequently that they are effective leaders.

Another type of memory is dynamic and associative. Individuals possessing this type of memory store a smaller volume of information than persons with a static memory. They possess an ability, however, to combine elements of information in different ways and to mobilize their reserve in a needed direction at needed times. They are continuous generators of new ideas and of new information, and this is particularly valuable in the case of situations required in leadership.

Taken by itself the type of memory that the individual possesses does not define his informational value. For in ad-

dition, a state of internal activity is also important, a striving to add to one's memory and generate new ideas that are then fed to other persons.

Finally, let us turn to a few observations concerning reliability. There is no doubt that man tires relatively easily, and that this produces a loss of attentiveness and a reduction in the speed and precision of his activities. Nevertheless he is far more reliable than are machines and his capacities for compensations and for flexibility are very great. Man's capacity to change forms of activity and to quickly transform information, make it possible for him to operate effectively in the most diverse and occasionally unexpected conditions within which a machine would cease to operate.

The reliability of the human brain is especially surprising, for it serves as a standard of reliability for regulation systems. The human brain is constructed in accordance with an hierarchical principle. Its higher levels carry out general functions of regulation bearing on the behavior of the organism, while local nerve ganglions directly regulate the functioning of individual parts and organs, in accordance, of course, with commands and sanctions of higher levels. Within the nervous system and the human brain, the element of mutual substitutability is very highly developed as is the mutual compensation of ganglions, tissues and cells. A situation in which one or several ganglions cease to operate by no means always interrupts the functioning of an organism. This is not the case with machines. There interruptions in the functioning of a particular subunit result in an interruption of the functioning of the entire machine and of the entire regulation system that it serves.

Finally, the most important distinction between man, the human intellect and the machine is probably this: man possesses a monopoly with regard to creativity and to the *production of new information* while machines are assigned functions of search and processing of already available information. This does not mean, of course, that machines are not able to create new information. Self-teaching automata do precisely this, but they do it not as a result of their own internal capacities, but rather in accordance with the will of man and in accordance with a program that again was created by the human intellect.

It is true that the problem whether a machine is able to be creative is subject to further discussions. And in our view it is possible to answer it only after one defines what is meant by creativity. If under creativity one has in mind activity that produces new results and yields new information, then computers, too, are able to be creative. In such cases one usually refers to such operations, carried out by computers, as pattern recognition, generalization, classification, comparisons, synthetic problems of diagnostics and the development of descriptions and interpretations.

In our view, however, it is not true that all activities that yield new information are creative in nature. A line in a multiplication table, for example, produces new information but the application of elementary arithmetical operations is by no means a creative activity. Instead they represent the most routine logical operations. The overwhelming share of all operations carried out by computers, however, refers to precisely elementary computational operations.

There is no doubt, that the entire part of thinking that can be formalized should not be excluded from intellectual creativity. For in that case, one would remove from the concept of creativity mathematics and other formal sciences which is, of course, absurd. But creative activities of the intellect which are concerned with acquiring new knowledge are not limited to formal operations. A dialectical approach to the object and results of cognition, intuition, associative thinking and emotional forms of cognition of reality, are equally important means of cognition, and perhaps, even more important than are formal-logical models.

It is here that one finds a clear watershed between machines and human operators: *machines are not able to think nonformally*. Machines can accept only that which is formalizable. Everything else belongs to man.

Beyond this all that is formalizable is the result of the creativity not of machines but of man producing machines and programming particular operations within it. It is man who is the creator of machine "creativity", which is merely a mechanical executor of man's creative will.

Creativity is a free act, while machines are not free in their selection. Creativity is a continuous act, while machine "creativity" is discrete and may be interrupted by simply

pressing a button. Machine "creativity" represents a crude and very distant imitation of man's creativity.

Finally, creativity represents a conscious activity that is intimately associated with intuition, with emotional content, with a continual search, with happiness at successes and bitterness of disappointment, and a ceaseless excitement and inspiration. It is only in this sense, that one should understand *creativity as a prerogative of man alone*.

Machines are not able to apply heuristic methods for solving problems which are the most effective ones and which constitute the principal distinguishing characteristic of the human intellect. And it is not surprising that an increasing number of scientists and specialists are saying that the further progress of "intelligent" technology must be based not on the creation of machines that carry out computations and other formal-logical operations, but rather on machines that imitate the specifically heuristic methods of problem solving that are characteristic of the human intellect.

Here, however, we enter into still another problem area, namely, the respective boundaries of formalization and of imitation of man's intellectual operations. If one approaches that problem from the formal point of view, then there do not exist any boundaries of formalization. That question, however, is precisely one of those in which a formal approach is not appropriate. Here a dialectical and a dialectical and practical approach is needed, and from such a point of view, it must be noted that there exists an enormous gulf between the possibility to formalize and to model the process of human creativity and its practical implementation.

2. INTERACTIONS BETWEEN MAN AND COMPUTERS IN WORK WITH INFORMATION

A number of trends may be clearly discerned in interpreting the nature of interactions between man and computers in work with information, in regulation, and in interpreting prospects for the further development of computers, and their intellectual, informational and regulation capacities.

First trend. *Computers cannot be compared in any way with man*, and their role in work with information and in regulation is negligible, not to say, harmful.

This point of view has been expressed most clearly by the French economist Georges Elgozy in a study entitled *The Disordinator: The Informational Threat*.¹

The author correctly observes that no matter how perfected an information machine may be, it is not able to guarantee a desirable form of regulation. It merely suggests to managers to combine technical, organizational, as well as economic knowledge and a high level of general culture together with the study of the experience of the most successful responsible persons.

Computers, in the words of Elgozy, are only able to calculate different variants of a solution, while the selection of a concrete solution always depends on man and on responsible persons. It is not possible to calculate events on machines that relate to the economy, sociology and the psychology of man and to human society. In solving complex social problems, intuition and creativity are always needed.

It is not possible to disagree with this, nor is it possible to disagree with G. Elgozy's assertion that the use of computers often produces financial losses (in the United States a high profitability was noted only in one case out of twenty, while in France only half of the computers have reached a threshold of profitability). The author also notes the inflexibility of computers which act as a constraint on the production process whenever it is managed with their help, and also the great expense that attaches to programming activities, as well as the lack of guarantees that the schemes produced by the machine will in fact correspond to reality. The precision of computers is also questioned by the author. A shift of a decimal point by one millimeter in a space research program will transform billions of dollars into smoke. The author also states that with no other machine has man lost so much time and resources. Accordingly, he concludes that information machines are successfully trans-

¹ G. Elgozy, *Le Désordinateur. Le Péril Informatique*, Paris, 1972, p. 54.

forming order into chaos and chooses to call them desordinators.

G. Elgozy sees the greatest threat of computers in the fact that they can cause man to forget how to think. He views as inadmissible and dangerous all attempts to express social life in quantitative terms, since the machine is not able to imitate life even for an instant. In his view the quantitative measurement of a society's qualitative parameters produces a threat to the very existence of mankind, while the attempts that are being made to arrive at such measurements represent misleading acrobatics.

While there is no doubt that Elgozy is correct in asserting that it is not possible to replace man with machines he is deeply mistaken in denying the possibility of expressing social life in terms of quantitative indicators. Both social and all other phenomena and processes constitute a dialectical unity of qualitative aspects and quantitative parameters, and a knowledge of that unity is a necessary condition for scientific regulation.

As for the computers themselves their great importance in identifying the quantitative parameters of qualitatively specific phenomena and processes in social life cannot be doubted.

Second tendency. *Machine thinking is not able to surpass the intellectual capacities of man.* The principal argument in support of such a point of view usually concerns the limitations that attach to methods of formalizing thought processes and those that attach to technical means for modeling the human brain. Unquestionably, the range of available means for formalizing elements of thinking is still very modest and at the present time it is primarily routine and homogenous logical operations that are formalized, since models of more complex thought forms still do not exist nor does there exist a mathematics or an electronic analogue of the human brain. In principle, however, there do not exist any constraints on the formalization of human thinking, and new thought operations are continuously being expressed in mathematical form. Already today machines are able to solve not only computational but also other problems, and the range of such problems is becoming increasingly wide and more diverse.

At the same time the size of computer memories is growing and this, too, increases their modeling capacities.

Let us consider, in this connection, the hereditary information that is contained in human chromosomes. The overall length of a DNA chain within a human cell is $2-3 \times 10^9$ and this is quite sufficient for over a million genes, assuming that the length of each gene corresponds to over one thousand pairs of elementary units, and that the number of chromosomes in man is 46. This means that on the average, there will be about 10^8 pairs of elementary units per DNA chromosome together with a similar number of bits of information. Each pair of elementary units carries two bits.

Already today there are computers that perform 12 million operations per second. The operational memory of a standard machine, such as the CDC-6600 (which is not the best) has a capacity of 131,072 sixty-unit binary words (approximately 6×10^6 bits) with an execution time of one microsecond. If one assumes that the capacity of the operational memory will increase by one order of magnitude every ten years (which is more than realistic), then already in 30 years it will be possible to record and store within a computer the entire hereditary information that is contained in the DNA of man's chromosomes or the whole genotype. It is supposed that after still another interval of time computer memories will be able to contain entire "populations" of such molecules numbering 10^3 , 10^6 and then, 10^9 "individuals". A single digital computer of "good quality" will then be able to store the genotypes of all mankind.

Nevertheless a mere increase in the memory of computers is insufficient for modeling the human brain, not to mention the evolution of all mankind. As is man himself, the human brain is above all a product of social evolution whose formalization in science has in fact not yet approached. But then, does there exist a need for such a formalization? It seems to us that such a need does not exist nor will it arise in the future.

As for our own times, self-teaching automata have already been created that first process information and then produce decisions that regulate operations without direct human participation and that also develop purposeful responses to

perturbances (adaptive systems). Self-reproducing automata are also being designed, as well as automata that reconstitute their own disrupted functions. Yet cybernetic technology is still taking only its first steps and its possibilities in the sphere of work with information are indeed grandiose.

Third trend. *Machines may exceed the intellectual capacities of man* and work with information more rapidly, more accurately, and in a more intellectual manner. However, man is able to control and direct the information activities of machines. One may agree with such a point of view, but with a substantial reservation, namely, by noting that while already today machines exceed the logical abilities of man, this is in *certain respects* only, rather than in general. In particular machines are able to compute and to calculate far more rapidly than can man (by hundreds of thousands and millions of times), to operate with a far larger number of indicators and magnitudes, and to analyze, compare and search for vast quantities of phenomena. They are also able to obtain information in spheres that are inaccessible to man either because of the distance of the objects being studied or of the dangers that they represent to health and life.

Machines exceed man in the accuracy with which they perform certain operations (particularly counting operations) as well as in the time of uninterrupted work with information. Similarly, the volume of memory of modern computers is enormous.

As for the control of man over computers, the need to maintain it cannot be doubted. In this connection N. Wiener has written: "I mean if we regard the machine not as an adjunct to our powers but as something to extend our powers we can keep it controlled."¹

Fourth trend. *The course of development of the human intellect and of machine intellect is so close that in the long-term they will merge into a single "integral" intellect.* Human intellect, however, will continue to develop in accordance with the laws of a social order, outside of which, that is, outside society, neither its emergence nor its further development is conceivable. As for machine intellect it is the product of the human intellect and of the mind and

¹ "Machines Smarter than Men?"—Interview with Dr. N. Wiener, *US News and World Report*, February 24, 1964, p. 85.

hands of men. It has been and will continue to be merely a dead, physico-chemical instrument, facilitating work and expanding possibilities for the human intellect. Machine intellect is, and of course will continue to be, integrated by society, but not as an equal component in relation to human intellect, but rather as a subordinate component and an auxiliary one which is free to the extent that this is necessary for man and for society.

Nor is the comparison between such an "integral intellect" and a complex centaur appropriate. This refers to the mythological centaurs resulting from a merging of human beings with horses in which both were integrated into a new type of animal (half man, half horse). It is misleading to think that human intellect and machine intellect will also merge into an equally surprising combination, consisting of half man and half computer, in which both man and machine are "dialectically overcome".

The issue is not to integrate man and machines into a new supra-natural and all-powerful being, but rather to amplify the best qualities of man by lending man the most developed machines for solving human problems.

Men and computers are far from being equal partners. In this connection, N. Wiener has observed that "The computer is extremely good at working rapidly, at working in a unique way on well-presented data. The computer doesn't compare with the human being in handling data that haven't yet jelled. If you call that intuition—I won't say that intuition is impossible for the computer, but it's much, much lower and it isn't economical to try to make the computer do things that the human being does so much better".¹

Fifth trend. *Machines will surpass man and will leave their control, will oppress man and displace him, and ultimately the epoch of human history will be replaced by the epoch of robots.*

In this connection a study by the American sociologist Lewis Mumford entitled *The Myth of the Machine* is of considerable interest.² In particular, Mumford accuses sci-

¹ "Machines Smarter than Men?"—Interview with Dr. N. Wiener, *US News and World Report*, February 1964, p. 85.

² L. Mumford, *The Myth of the Machine: Technics and Human Development*, N. Y., 1967, p. 4.

ence, technology, and scientists in having produced a situation in modern society in which monsters, namely, megamachines, prevail which do not serve any human purpose. Their purpose is an all-absorbing interest in receiving the greatest possible profits for corporations that exploit this machine. The author describes as empty-hopes the conception that "they (science and technology—*Ed.*) alone magically would provide the only means of human salvation".¹ Conversely, automation develops man as a robot that carries out the instructions of automatic machines without thinking.

While Mumford has noted accurately the specific traits that characterize automation within capitalist societies, he was not able, or else not willing to understand that machines play a different role in socialist society, where they appear not as a means of increasing the efficiency of production and the productivity of labor, but rather as a means for the intellectualization of labor and a many-sided development of man. It is this which explains his extremely pessimistic forecasts concerning the consequences of automation.

As for the long-term outlook about the development of computers and the replacement of men by superintellectual robots, the authors of such fantastic ideas forget to ask the opinion of men themselves: are they willing to sacrifice for the sake of machines? That characterizes mankind more than anything else, namely, the capacity and need for creativity. If they are then in sacrificing his creative core man will sign his own death warrant and will *cease to be human* being.

The question whether computers can undertake all human functions and work with information in the process of regulation is essentially one concerning whether machines can think. For work with information is thinking work, and beyond this, it involves the highest form of that work. While that issue has produced lengthy discussions, it has not been solved. It is extremely difficult to solve it, moreover, since essentially we do not yet know how man thinks.

In that connection I. B. Novik, a Soviet philosopher, writes that the modeling of psychic processes may develop along two distinct lines: either through the creation of machines

¹ Ibid., p. 4.

that would be able to do that which the brain does, and in the same way as the brain does, or else, through the creation of machines that do what the brain does, in a different way and on the basis of an internal mechanism that is different from the one employed by the brain. The second approach appears to be both preferable and also more fruitful, since it represents a liberation from a need to repeat nature, and does not require a preliminary detailed knowledge of these psychic mechanisms in order to model it on machines. Thought operations are then modeled in terms of their results rather than in terms of the processes on which they are based. With regard to information interactions between man and computers this means that it is the operations carried out by man in processing regulation information that would be modeled and entered into the computers, and beyond this, that they will be modeled on the basis of principles of machine organization, rather than of human organization. As a result, the question "can machines think?" is reformulated and acquires a different meaning, namely, "can a machine do everything that thinking man can do?"

In principle science has already given a positive answer to that question. The development of electronic computers, and of automated, as well as automatic regulation systems, is proceeding in the direction of shifting an increasing number of regulating functions, and more specifically, of operations with information from man to machines.

As for the question whether machines can think in a human way, its very formulation appears to be unjustified. For machines do not think in human ways, but merely imitate and model individual logical functions that are inherent to man and individual operations in regulation. This also refers, moreover, only to those functions and operations that do lend themselves to formal logical processing. The fact that the range of these operations is continually increasing does not alter this essential fact. Thinking, including creative work with information that is employed in regulation, continues to be a property of the brain and the living product of biological and social evolution, and thus continues to be social in its very nature.

In this connection it is difficult not to agree with G. N. Volkov, a Soviet philosopher, who writes that, indeed,

cybernetics does help to create "super-men", but not by synthesizing them in test tubes and combining them in clever ways with transistors, but by freeing man from mechanical and thoughtless labor and awakening millions of persons to intellectual and artistic creativity. The wide possibilities for electronic devices appear wherever man is powerless, or else imperfect. "With regard to generally human functions, however, man does not need substitutes: he will never want to deprive himself of the happiness produced by creative thinking of research activities, of the play of intellectual and artistic gifts and of emotional pleasures. In short, give to technology that which is technical, and give to man that which is human."¹

This can be stated better as follows: *give to man that which is human and give to the machine that which belongs to the machine*. The potentials of both man and machines, are truly boundless. The problem is to develop them and to use them in the fullest possible way.

3. THE PROBLEM OF "MAN-COMPUTER" DIALOGUES

One of the central problems associated with the automation of information processes and the rationalization of interactions between man and computers in work with information refers to the organization of exchanges of information between man and computers, or stated more simply, of *dialogues between them*.² In a substantial measure, the effectiveness of management depends on the effectiveness of such dialogues and the extent to which a mutual understanding between man and machines is in fact achieved.

There exists a number of ways for improving the information interaction between man and machines.

¹ G. N. Volkov, *Chelovek i nauchno-tekhnicheskaya revolyutsiya* (Man and the Revolution in Science and Technology), Moscow, 1972, p. 104.

² Cf., *Chelovek i EVM: (Psikhologicheskiye problemy avtomatizatsii upravleniya)* (Man and Computers: Psychological Problems in Automating Management), Moscow, 1973. This study contains a large bibliography on the problem (pp. 175-182).

The first concerns the improvement and development of information devices by improving the computers themselves, their peripheral equipment, and their mathematical and program software.

The second relates to the human component of "man-computer" systems by increasing the skills and training of human operators and by making fuller use of their abilities as well as by developing a psychological compatibility among groups of operators.

The third relates to improvements in the interaction between men and the computers themselves by improving signal devices and other technical, psychological, and ergonomic measures.

It is the discipline of engineering psychology that is concerned with the ways and processes through which man works with information, the nature and specific properties of the information interactions of man with machines, and the possibilities for rationalizing such interactions.

In a number of these problems the study of *man's capacity for working with information* and of the development of rational and effective modes for governing that work and for allocating human and machine functions within a single system occupies a central position.

The capacities of man to receive and process information are not boundless. Within a given time period man is able to receive a limited quantity of information, which, if exceeded, leads to errors, delays, and omissions. These increase further as the information capacities of man are further exceeded, producing a need for regulating and limiting information that is displayed to man as well as for carefully selecting and allocating information in regulation systems in accordance with man's capacities.

Specific information modes presuppose efforts to avoid information overloads, the superimposition of several information flows, and violations of the normal information capacities of signals (audio signals, light signals, etc.) as well as of excessive redundancy and a repetition of communications, since following an adaptation human operators cease to perceive the same information if it is transmitted too frequently.

Aside from establishing a rational mode of operation, it

is important to also create a *favorable* "information background" for work. This includes sources of information that do not have a direct relation to the work being carried out, and yet influencing those who are working. The setting created by the place of work, the visual properties of information, music, etc., should contribute to an increase in the productivity of labor and to a rational sequence of shifts from work to rest.

The process through which human operators work with information is composed of several stages, namely, the detection of signals, the recognition of signals, the identification of their meaning, their comparison with a specified regulation program, an analysis of the information that they contain, an evaluation of the situation, a decision concerning action, a collection of modes of action, and the action itself. Feedback signals make it possible for men to receive data about the outcome of actions and in this way a new cycle of regulation of information processing begins.

At the present time, definite conceptions relating to information interaction of human operators with machines have developed within engineering psychology. They include the conception of information models, of information searches, of equivalent subsystems, of throughput capacity, and of sequential activities.¹ All these concepts refer to different aspects of man's capacity and possibilities in work with information within machine-regulated contexts and to methods for optimizing that work.

The conception of an information model is based on the fact that within automated systems a direct regulation of machines is replaced by remote regulation.

As a result, the human operator is concerned not with the object itself (the equipment, technological processes), but with its *information model*. That model is constructed in accordance with specific rules and with the help of indicator devices. It constitutes, on the one hand, a reflection of the real processes that are being regulated by man, and on the other, an object of man's direct perception. It is the model,

¹ Detailed discussions of these conceptions are contained in A. A. Krylov, *Chelovek v avtomatizirovannykh sistemakh upravleniya* (Man and Automated Management Systems), Leningrad, 1972, pp. 50-60.

in fact, which is the direct basis for decisions and for corresponding regulating activities originating from the human operator on the object. Their reflection of essential object parameters that are important for regulation processes, the accessibility to the human operator of the code in terms of which the model is created, a consideration of man's information capacities and also of the content, order and complexity of the functions that he is carrying out—all these constitute requirements that information models must meet.

Information models create signals that are generated by technical devices and that are organized in accordance with specified rules. They provide a representation of the situation, and of the extent to which the system is achieving a specified objective. It also makes it possible to take a specific decision and to enter adjustments into the system's functioning.

Four basic types of information models are known:

visual, which reproduce the object or particular parameters of the object in terms of images and pictures;

abstract, or sign models in which information is embodied into specific signs;

graphical, which reproduce the object in the form of graphs and diagrams;

combined, which represent combinations of elements employed in the three preceding types.

In designing models it is important to take into consideration the fact that each of them is associated with a specific psychological structure of operations in the human operators receiving and processing information contained in a model, and presents specific requirements in connection with perception, attentiveness, memory, etc. The selection of models for a person engaged in the regulation of labor activities should be based on psychological factors.

The principal connecting link between human operators and computers, are *indicator devices*. These convey to the human operators the information on the basis of which decisions are taken. Improvements in the indicator devices, employed in management, increases in their capacity and in their ability to express a large volume and diversity of information, together with a continually greater adaptation to the psycho-physiological capacities and abilities of man

represent an important means for accelerating and further improving man's interaction with computers. Naturally information communications between man and computers can be affected not only through man's visual perception of indicators but also through audio-signals and tactile analyzers. At the present time, however, indicator devices continue to play a central role in such interactions.

Indicator devices include signal lamps, control measuring devices based on scales or dials, numerical control measuring devices, display screens, and mnemonic displays. These devices, or more specifically, the indicators on these devices are organized in accordance with specific rules and constitute information models of regulation objects on the basis of which human operators take decisions.

As further improvements take place in equipment and techniques there occurs a growth in the quantity of information that is needed to regulate them. There therefore occurs a sharp increase in the number of elements that are represented by indicators, as well as in the means of regulation associated with a single human operator. In the case of air transportation, for example, the number of indicators has grown from 50 units in 1940 to 100 in 1950, 200 in 1960 and already 350 in 1970. It is quite evident that the recording of information and the development of information modeling situations is becoming increasingly complex.

Mnemonic schemes are the most widely used indicators. They represent object of regulation by lighting indices characterizing object parameters and changes in its mode of functioning. As objects become more complex the corresponding mnemonic schemes become increasingly elaborate and the resulting large number of indicators influences the attentiveness of the operator and makes it difficult for him to concentrate on what is most important and to make operational decisions. At the present time the so-called "conceptual models" of the regulation objects are being introduced, which define the order in which indicators should be consulted—that order which best corresponds to man's capacities. Such models may be designed on the basis of logical relationships. This makes it possible to optimize the volume, "assortment", and form of displayed information required by the human operator, and to adapt to him the technical means

of regulation. Conceptual models make it possible to reduce by two or three times the time that is needed for an operator to estimate a situation and to take a decision. Structural schemes of the conceptual model types may be usefully supplemented by the use of diagnostic machines and methods of pattern recognition and of classification with the help of computers.

A multidimensional coding of visual information is widely employed. This makes it possible for man to perceive more information about the object of regulation and its environment within a specified unit of time. Unidimensional signals make it possible for the operator to utilize only one indicator, expressed either in terms of size, or color, or light intensity of an indicator. Multidimensional signals make it possible for operators to receive information concerning two or more parameters expressed in terms of one dimension or color, or else of the form, dimension and color of indicator simultaneously. Of course this requires that a specific scale for such codes be developed and be specified, that is, that there be a rational combination of different codes and the number of levels of coding within a multi-dimensional code.

An important parameter is the extent to which the information models that guide the operator in an automated system lend themselves to *visual perception*. This may not be simply reduced to the manner in which information should be displayed. The most important factor is not the composition of the way in which it is selected and what precisely it displayed on indicator devices, as well as which of the many characteristics describing regulation objects will be displayed to the human operator in order that he take decisions. It is one thing when all important characteristics are entered into a model, and another when the operator accesses a compact model containing only those parameters that determine the object's movement towards a given goal. In the first case, the operator confronts an excessive abundance of information and finds it necessary to carry out a supplementary analytical as well as synthetic processing in order to make the actual information model relevant to his actual situation. This, in fact, amounts to the development of a new model that makes it possible for him to take effective decisions. As a result there is a loss of time and of

capacity for effective decisions. This frequently produces a dangerous situation. Visual perceptibility in a wider sense, however, facilitates not only perception itself but also subsequent interpreting and thought processes. Such elements of visual perceptibility contribute to the remembering of information, the rapidity with which a situation is estimated, extrapolation processes, the activation of long-term memory, and conceptual modeling, all of which play an important role in regulation.

Frequently a scheme of regulation is designed in automating a particular process that provides for a part of the information about its course to be displayed to the human operator through the indicators of a control panel, while another is provided through a direct visual perception of the object itself. Under such an arrangement should the object of regulation cease to function correctly in several places at the same time, the operator will not be able to respond in time. This produces a danger of a disorganization and even of a complete cessation of functioning on the part of equipment. That, in turn, is the basis for the regulational process being effected from a central control position, so that comprehensive information be available through indicators and that the process of regulation may be effected in a centralized way.

In developing new means and methods of indication serious attention is being given to defining the permissible length of signal alphabets addressed to human operators and thus to the problem of the saturation of signals with information.

Because the capacities of man's various analyzers in receiving information vary, the admissible length of such alphabets must be determined in accordance with the mode of transmission of these signals. For a given mode the maximal information transmitted in the form of signals depends on which of their parameters (dimensions) are employed.

The fact, that the magnitude of the maximal information that a signal may carry is a function of those of its dimensions that are distinguished by man, implies that as the volume of information contained in the signal increases, so must the number of the dimensions that it must possess. In

short, in order that information be perceived by man, it is necessary to increase the number of distinguishing attributes of that signal as the measure of saturation of the signal with information increases.

Finally, in situations in which man works with a substantial volume of information, different types of notations and systems of standard signals and of groupings of signals and other objective scales are widely employed.

The design of indicator devices should be guided by a certain optimal speed in conveying information that is sufficient for maintaining a high level of activity on the part of man without exceeding his "throughput capacity".

Changes are taking place in the forms in which information is exchanged between man and machines. The principal determining trend in these changes is an *increasing approximation* of machine languages to human languages. At the present time machines "speak" with persons primarily in terms of the language of numbers and signs. There exist dozens of machine languages and new ones are continually being created in order that, first, it may be possible to facilitate man's communication with machines, and secondly, to extend the scope of their "dialogue" to a wider range of questions and problems that are to be solved by joint efforts. There is also an increasing use of computers that are able to display information in easily perceived forms, such as blueprints and graphs. In the Institute of Cybernetics of the Academy of Sciences of the Ukraine, for example, a machine called Mir-2 has been designed whose language is understandable to any mathematician, since the machine produces information on the screen in the form of ordinary mathematical formula.

The problem of man-machine dialogues is being solved in an interesting way on machines of the third generation. Display screens (which constitute a symbiosis of typewriters with television screens) make it possible to see the information that is being entered or else output by the computer in the form of texts, graphs, drawings, blueprints, etc., and to enter adjustments into that information immediately. The dialogue interaction mode that will be embodied in computers of the fourth generation makes it possible for human operators to cooperate with machines in solving complex

problems in information processing, including problems for which the programs are initially not known. In such cases human operators carry out a direct regulation of the machine on the basis of intermediate results of its operation. Dialogues between man and computers will be based on systems of interpretation, in which the form of information that is entered and processed in the machine, is similar to the output language, while the machine's instructions merely interpret expressions in the input language.

An ideal situation would exist if dialogues between man and computers could be carried out on the basis of natural human languages. Initially this will presumably be responses by machines to the human operator in terms of a "human" voice, to be followed by the perception and understanding of human voices by the machine, and then finally by mutual understanding, making possible a genuine dialogue between machines and men carried out in terms of human languages. It is not difficult to imagine the scope of the possibilities for using electronic computer that will then emerge. Its use will become a part of the labor activities and everyday life of individuals and it will become an instrument as familiar as our telephones and other technical devices.

CHAPTER IX

ORGANIZING SCIENTIFIC AND TECHNICAL INFORMATION

Before considering ways to improve scientific and technical information it is necessary to identify those features that are specific to activities concerned with scientific information and with exchanges of information in the sphere of science and technology.

1. INFORMATION ACTIVITIES IN THE FIELD OF SCIENCE

Scientific and technical information is one of the most important types of social information. It is embodied in technical and technological decisions, in knowledge, skills, and working habits of individuals concerned with the regulation of technological as well as social processes. That type of information is contained in books, in periodicals, patents, and design and technological, as well as other documents.

A newly emerged science, namely *informatics*, is concerned with the study of scientific and technical information. Informatics is a scientific discipline, which studies the structure and properties (but not the concrete contents) of scientific information, as well as the laws that govern its creation, transformation, transmission and utilization in different spheres of human activity, as well as its theory, methodology and organization.

It is in response to the needs of production activities for further development and in a context in which science serves increasingly as a direct productive force that this

new discipline has appeared. A need emerged for science to meet the needs of production, and for application of science and technology to the retrieval, storage, processing, transmission, and receiving of scientific and technical information.

The task of scientific information activities includes the collection, processing and storing of scientific and technical information in order that it may be rapidly supplied to scientists and practitioners; the provision of means for effective searches of data in spheres of knowledge that interest them; and the production of new data as a result of processing data that are already available through logical and retrieval systems. Informatics is concerned not so much with the process of receiving scientific knowledge, as with the result that is embodied in scientific documents such as books, articles, licenses, patents, etc.

Scientific and technical information is not the same as scientific knowledge. Scientific knowledge refers to the set of knowledge that is produced by a reflection of material and ideal reality within human consciousness. Scientific and technical information, on the other hand, refers to documented scientific knowledge entered into "circulation" and participating in the functioning and development of society. This is processed, classified and utilized knowledge, or else knowledge that can be utilized. It is knowledge that is utilized in communications of men with others, of man with technology, and of man with nature. It is knowledge that functions within the framework of informational-communicational systems that is especially selected and stored. It is knowledge that is utilized in the regulation of society generally, and in the regulation of progress in science and technology in particular.

Scientific and technical information services represent a necessary condition for rationalizing and increasing the effectiveness of scientific creativity, since it delivers information concerning the state of science both within the country and in the world at large as well as concerning discoveries that have already been made, current directions in research, scientific institutions, individual scientists, and specialists who are engaged in exploring a particular area. All this makes it possible to utilize those achievements in science

and technology that are already available, to avoid rediscovering and reinventing that which has already been discovered and invented, and to maintain ties among scientific institutions and individual scientists.

Scientific and technical information services supply data concerning scientific and technical discoveries to production centers and to other spheres of social life, and create the prerequisites for their embodiment into new technical equipment and new technological processes and into the knowledge and experience of working persons. It provides for an information interaction of science and production, and informs scientists concerning the current needs of production, thus motivating them to engage in current problems of further developing science and technology.

Scientific and technical information contributes to the elimination of duplication in scientific research and experimental and design work as well as to a reduction in the time required by studies and of expenditures on such studies. It enters corrections into scientific and design work, occasionally redirecting it along new channels that are more promising. Scientific and technical information produces a significant economic effect. Attempts are currently being made to identify that effect quantitatively.

Systems of information in science and technology in socialist countries provide regulation organs, planning agencies, ministries, and other agencies, as well as responsible officials of production associations and of individual enterprises with information for taking decisions concerning policies in science and technology at the level of the country as a whole, of sectors, of production associations, and of enterprises and organizations; concerning policies relating to major directions in research and development activities and to the training of scientists and specialists; concerning the financing of scientific research activities; and concerning organizational and technical measures in the field of science and production.

Scientific and technical information provides primary data for planning and forecasting activities bearing on the development of science and technology.

Forecasting refers to the identification of paths and possible results of the development of science and technology

over a more or less prolonged time interval. In terms of its trend, it serves the overcoming of contradictions between the needs and objectives of society, on the one hand, and the possibilities for meeting them, on the other. The means for resolving these contradictions are provided by continuing new developments in the field of science and technology. Since it is impossible to forecast accurately the time at which a particular new technical system will be created as well as its parameters, spheres of applications, and effect and influence on social relations, scientific and technical forecasts seek to identify and evaluate the general prospects for development in order that these prospects not be unexpected and that they may be utilized as quickly as possible. It is thus with the identification of possibilities for the development of science and technology in the foreseeable future, and the preparation and realization of these possibilities and their acceleration in order to arrive at scientific discoveries and their applications as quickly as possible that the essence of forecasting is concerned.

There exist two types of forecasting of activities in science and technology. The first is called normative forecasting and is concerned with means for achieving specified needs and objectives. Such forecasts constitute, in a sense, a movement of thought from the future to the present. The second moves from available scientific and technical possibilities to new possibilities (explorative forecasting). Forecasts of this type represent a movement of thought from the present to the future. Under normative forecasting, normative information serves as the initial point of departure which determines the value and importance of the particular trend within a set of others in the light of objectives confronting society and of existing needs. In the case of exploratory forecasting, which is based on information concerning the state of science and technology at the present time, trends are identified as well as new possibilities without regard to needs and objectives, and without considering the practical needs for and value of scientific discoveries. Integral forecasting under which the exploratory approach is complemented by the normative one, is especially effective.

In socialist countries plans for the development of science and technology are elaborated on the basis of long-term

forecasts. These represent informational documents of a prescriptive nature. Such plans contain a system of interdependent specific indicators in the sphere of science and technology whose achievement within the planning horizon is an objective of the regulation subject. Plans also indicate the order and sequence, as well as schedule times that attach to particular indicators.

Because they are informational documents, forecasts and plans are intimately associated with each other. Plans are constructed on the basis of forecasts. The methods for achieving objectives that are defined in the forecasts, however, may differ, and for that reason, *policies in science and technology* represent an intermediate element between plans and forecasts. These define, on the basis of forecasts, the scientific and technical conception and structure of the national economy that is embodied into the long-term plan.

Unlike in the case of planning, which is carried out on the basis of precise and reliable information, forecasting is based on information of a probabilistic nature.

Science is a necessary attribute and foundation of social regulation that operates as an important factor for intensifying production processes and social life as a whole. The development of a theoretical foundation for production management, as well as of the regulation of social and cultural processes and of corresponding practical recommendations, constitutes one of the most important tasks of Soviet science. Social life, production and culture are so complex and varied today that it is not possible to regulate them without the help of science and without utilizing the most modern scientific and technical means. This defines the growing role of scientific and technical information in social regulation activities.

In the meantime the current system of information in this area has been developed under the influence of the needs of scientific research activities. There are important distinctions between scientific research activities and regulation activities among which the most important one relates to the fact that regulation decisions which should be served by scientific and technical, as well as other types of information are usually taken under conditions in which there is both insufficient time and insufficient information. This

refers to necessary information, since decision-takers require not raw, unprocessed information, which is always available in abundance and literally drowns them, but rather processed, deeply analyzed and generalized information.

In practice, this distinction is generally not taken into account. As a result, the specific traits of scientific and technical information that decision-takers need for taking organizational decisions are not identified to the needed extent. A. I. Mikhailov¹, a prominent Soviet specialist on informatics, believes that scientific and technical information must meet at least the following requirements: a high degree of analysis and synthesis of scientific information; the least possible volume for a given content without loss of comprehensiveness; reliability and accuracy; a forecasting aspect; and the delivery of information on time. In his view, the scientific and technical information subsystems of Automated Management System (AMS) must be supplemented by a center of information analysis and synthesis, which produces scientific and technical information designed specifically for regulation bodies and decision-takers.

Exchanges of scientific and technical information possess traits that are common with those of exchanges of any other type of social information. In particular one always finds a source and a user of information and the information and the environment within which the exchange occurs. Each component of such acts of exchange, however, is highly specific.

In such cases the *primary source* of information is also frequently its creator. Scientific and technical information, moreover, is a result of the creation not only of specific currently living scientists or collectives, but also of preceding generations of scientists and specialists. The collective nature of creativity in the field of science and technology and literature has been expressed very well by the great poet and thinker, Goethe: "since all of mankind should be viewed as a single great student, none should feel vanity with regard to his own skills. Isolated persons never reach their goal..."

¹ Cf., A. I. Mikhailov, "Podsystemy nauchno-tekhnicheskoy informatsii", *Avtomatizirovannye sistemy upravleniya* (Scientific and Technological Information Subsystems, Automated Management Systems), 1972, p. 262.

"What am I myself? What have I done? I have collected and utilized all that I have seen, read and observed. My works have been fed by thousands of different individuals, both ignorant and wise, intelligent and stupid; childhood, mature years, old age, have all brought me their thoughts, their capacities, their hopes, and their way of living; I have frequently reaped harvests sown by others, ... my labor is the labor of a collective being, and it carries the name of Goethe."¹

Let us now consider the *users* of scientific and technical information. They may be divided into four groups: research scientists; specialists in national economy; political and managerial workers, workers and specialists in management systems; and members of specific social groups.

The objectives, needs and interpretation of scientific and technical information of each of these groups differ substantially from each other.

Research scientists require scientific and technical information in order to orient themselves, to identify what has been done by other scientists in a particular area of science and technology, to facilitate the search for solutions of particular problems, to establish contacts with other scientists, etc. Specialists, on the other hand, are especially interested in applied problems and studies, and in licenses and patents, to help them utilize available achievements of science and technology in practical ways. Political and administrative circles, planners and policy makers require information in order to develop policies, including policies in the field of science and technology and for forecasting, planning and management. Finally particular social groups generally emphasize the educational aspect of information.

It is interesting to note that sources of information and users of information must be engaged in closely related fields of science and technology (this does not refer, of course, to popular scientific literature). Otherwise communications would not be understood. The language of scientific

¹ V. O. Likhtenstadt, *W. von Goethe. Borba za realistichekoye mirovozreniye* (W. von Goethe. Struggle for Realistic World Outlook), Petersburg, 1920, p. 396.

and technical information is quite specific. It is expressed with the help of the terminology employed in science and technology and represents a specific and familiar system. That system possesses distinctive ways for expressing information (formulae, diagrams, graphs, symbols) as well as a high measure of terminological specificity.

In this connection, L. O. Reznikov, a specialist in the theory of cognition, notes that scientists rely on signs because they make it possible to express the corresponding conceptions in *abbreviated form*;

—they possess, by convention, a precise meaning, that is, they fully meet the requirement for a *unique correspondence*;

—they create conditions for a *visual perception* of theories and of internal relations among all its elements and parts;

—they identify conceptions for which there are no *corresponding verbal expressions* in ordinary language;

—they may contribute to the *emergence of new conceptions* and prepare the way to the *discovery of new objects, properties and relations* within reality;

—they contribute to the establishment of a structural *homogeneity*, and the unity of certain general laws in different fields of reality;

—they favor the development of world science because of the *international scope* of their application.¹

All this facilitates the exchange of scientific and technical information very considerably.

Let us consider, finally, the *environment and conditions* in which scientific information is exchanged. They, too, are specific and constitute a particular scientific institution within which direct communication occurs. This could be a scientific institute proper, a scientific conference, a symposium, or a seminar.

It has been estimated that approximately one half of the information that interests scientists and specialists is received from oral sources, from conversations with colleagues, reports and communications within university departments,

¹ Cf., L. O. Reznikov, *Gnoseologicheskiye voprosy semiotiki* (Problems of Semiotics Bearing on the Epistemology), 1964, p. 303.

seminars, symposiums, conferences, etc. This points to the exceptional importance for science of direct contacts. Especially today, when scientific discoveries are acquiring a collective character, such contacts constitute one of the principal sources of information and of the generation of new scientific ideas.

Personal meetings among scientists represent an elementary form of such scientific contacts. These are not constrained in terms of either time or space, the relation to the subjects being discussed, and this is a major advantage. In the course of such a meeting it is possible to discuss a problem comprehensively, to learn in detail the opinion of participating persons, and to solve problems. The shortcomings of personal meetings relate to their limited number of participants (frequently, it is only two) which reduces the volume and contents of information exchanges. Personal meetings are a necessary accompanying element of all other types of more complex and more multilateral forms of communication. When there arises a need for a wider discussion of problems, and in particular, when personal meetings have not led to the desired results, a *conference* is called.

It is important to organize conferences with some precision and also to compare resulting outcome with the expenditures arising from the interruptions of the normal activities of a large number of workers that they entail. Invitations to conferences of persons who are not competent to discuss corresponding problems also produce informational perturbances, since their contributions divert the attention of participants from the discussion of a specified problem, burden participants with unnecessary information, and lead to an excessive waste of time. The composition of conference participants should be strictly limited to competent persons. The absence of rules of procedure governing conference activities and excessive verbosity increase the information load on participants producing indifference as well as a loss of attentiveness. It is also important that discussions not be interrupted. Discussions that have not taken place are harmful from the point of view of practical results.

Colloquia are still another form of collective meetings. They usually involve exchanges among scientists from different branches, within a procedure in which everyone

present participates in a nonformal discussion. In the case of colloquia there are no official contributors, and contributions are not followed by critiques.

Unlike colloquia, *symposia* represent semi-official discussion where reports are prepared in advance as well as *ad hoc* contributions. Participants of symposia may be present for only some of the contributions and may meet in hallways. As for the small number of guests who are invited to symposia, they are usually observers. Critical comments are invited in symposia.

Conferences probably represent the most widely employed form of exchanges of information. One part of conference participants are contributors who communicate new scientific ideas, the results of experimental studies and of production experience, and reply to questions. Another part, which is much larger, constitutes the audience to which the information is addressed. Members of the audience may ask questions and participate in discussions. Both contributors and members of the audience are subjected to a substantial information load. In order to reduce it strict rules of procedures govern the contributors and persons participating in discussions and the work is divided into sections. Frequently, conferences are accompanied by exhibits of books, samples and graphic materials. Scientific organizations and educational institutions frequently hold conferences periodically (yearly, in connection with certain dates, etc.) and frequently such conferences adopt decisions and recommendations.

Finally the highest and most representative form of communication are *meetings* and *congresses* that are either national or else international in scope, at which the most important issues relating to the development of science and technology are discussed and disseminated, new ideas are approved, and new strategies in the sphere of scientific research in particular fields of science and technology are developed. Such forms of communication as *opinions* are becoming more numerous and acquire increasing significance in contemporary science. Discussions circulate widely within science and to a large extent take the form of exchanges of different opinions.

The content of the conception of the "opinion" is not defined very precisely, and frequently it is employed in

ways that are not fully justified, as in the case when it refers to conclusions, assertions, and theories whose truthfulness does not produce any doubt. The use of the conception "opinion" is apparently justified in those cases in which the point of view of a scientist, or a specialist, or institution is expressed, in relation to a particular debatable or unsolved question.

In the view of others, however, the concept of "opinion" refers to scientific communications that pretend to be only partially correct.

Scientific communications possess both functional properties and attributive properties. It is from this that the two types of use of the term "opinion" follow. The first refers to situations in which a scientific communication possesses a measure of truthfulness that may be associated with the nature of the source. The second refers to situations in which the attribute of partial truthfulness manifests itself in a functional manner.

Any scientific opinion may be truthful, partly truthful, or false, yet the measure of its truthfulness (or falsity) is determined in the course of exchanges of opinions and most often, only after such an exchange. Yet "opinions" always represent a communication possessing an informational value. In all cases, except those involving clearly absurd opinions, they contain initial information for further scientific explorations, both theoretical and experimental. During that process, false or erroneous opinions are rejected and opinions whose truthfulness is proven, are added to the permanent store of scientific values and to the general reserve of scientific information.

We have seen that exchanges of scientific and technical information are characterized by specific traits.

The volume of scientific and technical information is continually growing, together with the number of scientists and of contributions to science. The earth's population is doubling every 35-40 years, the number of scientists every 15 years, and the volume of scientific information every 10 years. If that trend were to continue, then in 200 years, the population would consist of 100 billion persons, including 24 billion scientists, and the volume of scientific information would be a million times larger than it is today.

Even more worrisome forecasts are being advanced. It has been calculated, for example, that if the current indicators of development in science should continue, then in 150-200 years, science will require the expenditure of all resources that will be available to society and the entire population of the earth will consist of scientists. On that basis, it is suggested that the rates of development of science will inevitably be reduced and the rates of production of scientific information will substantially decline.

It cannot be stated that such a conclusion is justified, since it is based on the contemporary state of science and on current criteria and indicators in its development. And it is by no means surprising, that it is being supposed that in the course of time criteria and indicators of the development of science will change. Science today is developing extensively, for the most part at the expense of the growth of qualitative indicators, which even though they are necessary and important, are neither comprehensive nor exclusive. A turning point in science has taken place towards *intensive* and *qualitative* factors of development which makes it necessary to have other types of criteria in the evaluation of both the activities of scientists and of scientific institutions as well as the development of science as a whole.

The improvement of scientific and technical information systems and the upgrading of the informational training of scientists and specialists represents an important means for the intensification of science.

2. THE FURTHER IMPROVEMENT OF INFORMATION SYSTEMS IN SCIENCE AND TECHNOLOGY

The rate of development of science and technology largely depends on the extent to which information concerning the most recent achievements in science and technology is conveyed to production units in time. As the rate of transmission of information from sources to consumers of information increases (and in this case, the principal consumers are producers) so does the rate in which scientific and technical ideas are embodied into technical and technological innova-

tions and into the knowledge, skills, and work of specialists, as does the rate at which further progress in science and technology occurs and at which increases in the productivity of labor and in the effectiveness of production take place. It is especially important to note this because a given increase in the volume of production requires a volume of increase in the necessary information that is the square of that figure. If, for example, it has been decided to double the volume of production, the volume of information that is needed to make this possible will increase by four times. It is therefore not surprising that the volume of activities of scientific and technical information services increases continually and that expectations attaching to such services also increase. Any interruptions and shortcomings in that sphere operate as a negative influence on scientific and technical progress and on the effectiveness of production.

The volume of scientific and technical information has been growing extremely rapidly. Each year nearly 700,000 reports concerning scientific research activities are published throughout the world, as well as 85,000 new articles and more than 700,000 applications and descriptions of inventions. Nearly 100,000 scientific journals are published in 60 languages, as are 250,000 scientific dissertations and surveys and more than 400,000 patents are recorded. Millions of books are printed. Nearly 1,500 pages of text concerned with new developments in science and technology in specific areas of industry are published each day.

Such an abundance of scientific and technical information produces a negative effect on progress in science and technology. For the growth of information in science and technology is not accompanied by a corresponding increase in the number of new original scientific and technical ideas, and to find these ideas within the enormous volume of publications and patents is becoming increasingly difficult. Both in the Soviet Union and other countries many researchers have established that research workers devote a large share of their time to searching for information, and that they by no means always find what they need. In these activities unsystematic individual approaches prevail. The lack of information concerning discoveries and inventions that have already been made results in a

useless expenditure of efforts and resources, in considerable losses in time and reduces the rate of scientific research activities. Because of the lack of knowledge concerning scientific and technical literature, at least one half of the research and design activities that are currently taking place are duplicating each other.

The blame for such a lack of information may be primarily attributed to the scientists and specialists themselves, since a large number of them have not acquired the needed working habits. As a result, specialized personnel and large groups of such persons expend much time and resources in order to rediscover what is already known. It is therefore not surprising that a large number of applications for inventions are rejected already at the stage of preliminary evaluations, and that a still larger part cannot be recognized as inventions because they are not new. Literally thousands of research groups are engaged in activities of this type. And frequently, this is not because the persons who work in these groups are not able to be creative, but rather because they either do not know how to orient themselves in scientific and technical information, or else are not willing to do this.

It should be added that scientific information services are not yet playing the role in science and technology that is appropriate to their function. And not all scientists and research specialists respond attentively to the services of specialists in information. Yet it would be appropriate to consider it as a general rule that no major scientific research or scientific development can be initiated without the most thorough study of already available experience. Only then can one be certain that the activities of groups of scientists or developers will correspond to the best world standards and surpass them. This is true, of course, only if the specialists in information themselves measure up to the corresponding requirements in their own field.

It would be wrong, however, to believe that it is only scientists and specialists who are to blame for the inadequate state of their information. It has been estimated that even if the specialist were to read the literature that he needs, 24 hours a day, he would come to know only one-twenty-fifth of the literature in his field. It is, therefore,

the shortcomings in the scientific and technical information systems that are relevant.

In order to increase the rate of progress in science and technology it is necessary to organize systems of scientific and technical information rationally, and to teach scientists and specialists modern methods and forms of search and information retrieval and utilization.

The CPSU and the Soviet Government attach great importance to the creation and improvement of a system of scientific and technical information.

In the Soviet Union a highly effective system of scientific and technical information is being established to help scientific workers in carrying out research work and in avoiding unnecessary expenditures of time and resources, and the duplication of activities. As a combination of territorial and sectoral information services with country-wide information services in the USSR such a system has already been created and is being improved.

It includes 10 all-Union, 82 sectoral, and 15 republican institutes, as well as 68 territorial centers and nearly 9,000 local information units possessing scientific and technical libraries associated with large enterprises, research institutes, and design units.

An important component of the country-wide system of scientific and technical information is provided by scientific and technical libraries, of which the largest is the State Public Scientific and Technical Library. In 1976 its collection exceeded 8 million volumes, and each year an additional 700,000-800,000 publications are recorded. Nearly 100,000 persons and 8,000 enterprises, organizations, and scientific research centers rely on its services.

A central role in the preparation of information concerning scientific and research activities is played by the All-Union Scientific and Technical Information Center, where research studies are registered. Nearly 200,000 documents are added to that collection each year that reflect the subjects and outcomes of scientific research activities. Experimental design activities are also recorded.

Similarly an important contribution is provided by the All-Union Institute of Scientific and Technical Information of the USSR Council of Ministers' Committee for

Science and Technology (VINITI). Towards the middle of the 1970s that institute processed 40,000 titles drawn from the world's scientific and technical literature published in 130 countries and in 66 languages. Nearly 200 issues of its "Reference Journal" are published each year, as well as 70 series of "Express Information", more than 50 series of signal information, and other publications.

The Institute of Scientific Information on Social Sciences produces nearly 900 information publications each year, including 220 reference collections and journals.

The reference information collections of institutes, centers, and offices of scientific and technical information contain more than a billion different items.

Improvements are taking place in the forms and methods of work employed by the system of scientific and technical information. Gradually a selective method of information dissemination is being introduced, in the sense that specific types of scientific and technical information is first sent to those organizations and persons who are specifically interested in receiving it. Such a method of information dissemination is employed by a number of agencies and information institutes. In particular, the Institute of Scientific Information on Social Sciences disseminates information selectively among Academicians and Corresponding Members of the Academy of Sciences of the USSR. Similarly, in the case of a number of enterprises, information is delivered directly to the offices of individual specialists.

Automated information searching systems (AISS) based on computer technology are being established. These systems are able to provide comprehensive answers to specific questions relating to the development of science and technology, that is to provide the kind of concrete and specialized information that scientists and specialists require.

In particular an automated scientific and technical information system called "Referat" has been jointly developed by the Research Institute of Controlling Machines and Systems in Perm and the Central Research Institute on Information and Technical-Economic Studies in Instrument Design. This has been introduced in the Ministry of Instru-

ment-Making, Means of Automation and Control System.

That system's collection of information is based on contributions of individual organizations within that sector in specific subject areas that have been assigned. Their contributions are forwarded to the information processing computer center in the forms of summaries entered on standardized forms containing short descriptions of articles, monographs, dissertations, patents, findings of completed research, and developmental activities and production experience (both domestic and in other countries).

The summary's text is encoded with the help of descriptor dictionaries and is assigned a specific code number. Their search indices are entered into the computer's memory. Microfilms of the texts of such summaries are then also entered into an automated storage device whose capacity is two million microfilm summaries.

The "Referat" system produces only information references that contain new information. In particular it provides answers to both standing and individual questions and reference cards for individual subjects. It also provides materials for reference collections in individual sectors and it provides complex scientific and technical information services to specialists working in such sectors.

The initial experience with the "Referat" system has provided a basis for developing a still more perfected scientific and technical information system that would make it possible to carry out automatically a search and retrieval of specific data from the information blocks that are stored in computer memory and to process them in terms of their meaning. This will make possible a direct communication between clients and the machine.

In the USSR such information retrieval systems are being established in a number of ministries, agencies, scientific research complexes and enterprises.

As they merge with communications channels, such reference information systems may produce data banks that are national in scope within particular sectors of knowledge. Such data banks will automatically convey information to all interested agencies and enterprises. The resulting system, moreover, will be continuously increased through information concerning new discoveries and achievements.

A national information bank in particular areas of knowledge represents a mirror, as it were, in which the current state of that sector of knowledge will be reflected at each moment in time.

There are still many bottleneck areas in the work on an information service, and internal potentials for improvement are considerable. As a result many new developments in science and technology are not applied in production and in social life.

In particular the fact that scientific information systems are organized in terms of sectors constitutes an important shortcoming. For today, science is engaged in studies of many complex systems-oriented problems which call for similarly complex information services.

Similarly, under a sector-oriented organization of scientific information services there is an autonomous approach to the referencing, annotating and indexing of all relevant literature. Individual sources of information are then frequently processed a number of times. This results in duplication and unnecessary expenditures of time and resources.

A gradual transition from sectoral information systems to complex integrated information systems is currently taking place in the USSR. Under such an approach the sources are processed only once before being entered into a system, and the results of their synthetic processing are also entered into the system only once. Subsequently, the information may be assessed an unlimited number of times. Such integrated systems contain complex information that is able to meet the needs of both specialists engaged in sectoral problems and those engaged in complex problems.

Finally, a certain experience has already accumulated in developing integrated complex information systems. An example is provided by the intersectoral territorial center of scientific and technical information and information dissemination in Leningrad (LTsNTI). In this case nearly 60 scientific research and development institutes as well as the central office disseminate intersectoral information. The center possesses a unified information bank to which approximately 400,000 items are added each year, as well

as a collection of patents, containing descriptions of nearly 9 million patents (for the USSR, the countries of the Council for Mutual Economic Assistance, and capitalist countries). The center provides references both in written form and by telephone. There is always an engineer on duty who provides 40 to 70 references each day. The center is closely linked to enterprises. Each year more than 10,000 items are sent to enterprises and organizations. Selected information announcements are published each week, as well as a Bulletin.

In addition to providing a rapid redistribution of the scientific information needed by enterprises and organizations and to economizing the time of researchers and specialists in this way, the center also reduces expenditures on the assignment of specialists to other organizations. Following the organization of its patents collection, the corresponding savings to industries located in Leningrad have been 500,000 rubles each year.

In the long term it is possible to create a unified country-wide automated scientific and technical information system in the Soviet Union. It is envisaged that its subunits will be specialized. In particular, central (complex and sectoral) bodies will primarily specialize in analytic and synthetic information processing. It is expected that the results of that work will be recorded on magnetic tapes and magnetic discs and distributed to units of specialized information services that will directly serve the users. These units may be other branches or subdivisions of information processing centers.

Information service units must possess an hierarchical structure that takes into account the territorial and sectoral divisions of society. A request for a particular information reference is received at such a structure's lower levels and is forwarded to higher levels only in cases of need, that is, when the required information is not available at lower levels. In order that a request for information will immediately be forwarded to the proper address such an information service should possess a network of "information reference" bodies that will indicate the addresses from which the information needed by scientists and specialists can be immediately obtained.

This entire system is being equipped with standardized computers and unified communications channels. Through telephone and radio relay channels the centers are linked to users of information (institutes and organizations) that both provide new information and data to the centers and also receive from them information in areas that interest them.

It is difficult to overemphasize the advantages of integrated reference information systems. They make it possible for researchers to economize a very large amount of time that is currently being spent on the collection and study of information and to avoid studies of problems that have already been solved elsewhere.

CHAPTER X POLITICAL INFORMATION

Political information holds a central position within the system of social information. In order to grasp its essence it is above all necessary to consider its relation to the political sphere of social life which it reflects.

1. THE POLITICAL SPHERE OF SOCIAL LIFE AND POLITICAL INFORMATION

Political activities and the political sphere of social life represent an extremely wide and multifaceted phenomenon.

They relate, above all, to *political relations*, which refer to relations among classes (internal policy), among nations (nationalities policy), and among states (external policy). Objectively, political relations develop on the basis of the economy and above all, on the basis of the prevailing form of property rights over means of production. These relations are expressed in concrete ways in the activities of classes, nations, and states, and more specifically in struggles among classes and for national liberation in the case of societies based on class antagonisms, in cooperation among classes and nations in the case of socialist society, in fraternal friendship and mutual assistance in the case of relations among socialist states, and in peaceful coexistence in the case of relations among states with different social structures. Relations among classes may develop spontaneously and may be unorganized, poorly organized, or else, well-organized. As they enter into specific

relations, however (of struggle or cooperation), classes are always guided by class interests, whether or not these are consciously perceived. Class relations represent a largely objective aspect of the political sphere of social life since the class structure itself and the nature of relations among classes are more or less clearly determined by its material conditions. They emerge on the historical stage when particular material conditions develop, and they leave the historical stage only when these conditions disappear, yielding to other classes.

Political activities and the political sphere also encompass *political organizations*, which exist in a class society and which protect the interests of individual classes. These include, above all, the state, which is formed by the ruling economic class in order to assure its political dominance. They also include political parties that combine that part of a class which is most active in expressing and defending its interests.

Political activities and the political sphere also encompass the *political organization of society*, which represents a system of party, state, and nonstate bodies and organizations. In addition to parties and the state, that system includes trade union, cooperative, youth, sports, creative and other organizations, that either directly or indirectly regulate various aspects of a society's life and development.

Political activities and the political sphere also refer to the *political course* of parties and states, both within a country and externally (political activities in the narrow sense of that word). Such courses describe the main direction in the activities of a party and state and the main objectives that they envisage for society as well as the principal means for achieving these objectives.

In such a sense, the term "political activities" is often justifiably employed in referring to spheres of social activity that are, strictly speaking, not political, as in the case of economic policy, policy in science and technology, social policy and cultural policy. This is because the political, class approach penetrates all spheres and all fields of society, and particularly the economic field. It is not surprising that V. I. Lenin has described political activity as a concentrated expression of economic activities which ex-

tends them and generalizes them. It is precisely in the sphere of political activities that the economic interests of individual classes find their fullest and most comprehensive justification and expression. In this connection V. I. Lenin wrote that "without a correct political approach to the matter the given class will be unable to stay *on top*, and, consequently, will be incapable of solving *its production problems*".¹

Finally, political activities and the political sphere include *political ideology*, which expresses and generalizes political relations, political organizations, and the political organization of society, as well as the prevailing political course and overall political leadership. Political ideas include the views of a particular class with regard to class struggle and revolution, the construction of socialism and communism, the nature of that class's relations with other classes and social groups, relations among nations and states, questions of war and peace, the organization of society and the role of the state, the methods of political leadership and management which are employed, and the objectives and means employed in current forms of struggle and creative activities. These views serve as a guiding principle in defining the activities of classes, parties and states as well as of other political organizations. They are carried out and find a practical embodiment in direct forms of class struggles, in activities of political organizations, in programs, declarations, slogans and appeals of parties, in the constitutions of states, and in special theoretical studies as well as other documents.

At the present time there is a sharp struggle in the world between opposing political ideologies—that of the working class, on the one hand, and of the bourgeoisie, on the other. The political ideology of the working class is socialist in character. It is the ideology of proletarian internationalism, of friendship among workers of all countries, and of unity and cooperation among all progressive forces in a common struggle for peace, democracy, and socialism. It finds its most comprehensive expression in Marxist-Leninist theory, in the programs of Communist parties, and in the constitu-

¹ V. I. Lenin, *Collected Works*, Vol. 32, p. 84.

tions of socialist countries. That ideology clarifies the underlying grounds for the class struggle of the working class and of all workers against the bourgeoisie, and for the inevitability of a victory for socialism and communism. It serves to guide the working class and its allies in their struggle against capitalism and for the establishment of new socialist and communist societies.

Opposing the political ideology of the working class are the political ideas of the bourgeoisie, whose aim is to sanctify capitalism and preserve it forever, together with private property and exploitation. These ideas seek to provide a basis for a policy of the repression of the working class, the policies of aggression and national oppression, and hostile policies in relation to world socialism.

In the struggle between these two ideologies the political ideology of the working class has been recording one victory after another. It represents an ideology of revolutionary struggle, of destroying the old and constructing and creating the new.

Thus political activity and the political sphere of society represent a complex synthesis of objective elements with subjective ones, of spontaneous and conscious activities, and of practical endeavors with theoretical ones. In socialist societies, moreover, an increasing role is played by the conscious, subjective, theoretical and scientific side of political activities, which sheds light on the path to be followed and guides the objective movement of the entire political sphere of social life, and beyond this, of all spheres of social life towards given objectives.

Political information constitutes a reflection of the political sphere of social life and represents the sum total of all communications concerning phenomena and processes taking place within that sphere. Political ideology, on the other hand, represents its highest and systematized expression.

The role of a political ideology within a society is quite specific. On the one hand, it is a component of the society's political sphere which penetrates all its other spheres in a variety of ways. At the same time it represents a part of political information and serves as its axis, and as the theoretical foundation of the prevailing political line and political leadership.

Marxist-Leninist ideology plays a very large role in the regulation of a socialist society. It serves as the theoretical foundation of the policies of Communist parties that provide a basis for scientific regulation, including the selection of objectives and of basic methods and means of leadership. It also provides a fundamental class criterion in estimating the effectiveness of regulation systems and processes, and in helping the sovereign regulation subject, namely, the working masses, in their political and moral orientation and in their view of the world. It serves as the theoretical basis for developing a democratic system for regulating socialist societies and for bringing about the participation of millions of workers, farmers, and intellectuals in that process. It defines the basic principles of regulation and serves as a guide in the education and training of executives and other responsible leaders.

The important role that attaches to the authority that a decision-making person or body possesses is widely known. It frequently makes it possible to achieve results that are substantially greater than through the mere use of power. This is because authority is acquired through competence in a given field of responsibility with due account of relevant achievements in science and technology. Decisions taken by authoritative bodies and persons are carried out even in the absence of coercion. In such a context ideology contributes to a transformation of power into authority, and hence, to a reduction in applications of coercive regulations. This is especially characteristic of developed socialism.

The scope of political ideology, however, is less than that of all political information. The sphere of political life is extremely complex and diverse and is not fully encompassed by political ideology, which is only an outcome, a concentration, and a scientific generalization of a large mass of information concerning political events. In this connection, V. I. Lenin has observed that "...we Marxists must exert every effort to make a thorough-going study of the facts underlying our policy".¹

The sum total of information concerning the political sphere of social life constitutes *political information proper*,

¹ V. I. Lenin, *Collected Works*, Vol. 25, p. 275.

in the narrow sense of that word. This includes, moreover, not only information concerning the overall internal political life of a given country but also concerning political events abroad.

The term "political information" is also used in a wider sense as information relating to the economic, social, and cultural spheres as well. The grounds for associating them with political information are that in class societies economic, social, and spiritual processes inevitably acquire a class-related role and a class content, and are consciously directed in such a way as to serve the politically dominant classes. It follows that information concerning these processes serves *class policy* and is employed as an important means for developing, advocating, and carrying out policies.

Thus political information is a major element of social information which encompasses above all phenomena, facts, and events in a society's political sphere—i.e., relations among classes, nations and states. This includes communications concerning events and phenomena occurring in other spheres of social life that have a political significance and especially in the economic and cultural spheres. Such a definition appears to encompass both the narrow and the wide meaning of the concept of political information.

Political information represents a very complex and diverse system of knowledge. It encompasses information that differs in terms of its significance (overall social information and local information), as well as with regard to its level of generalization (ranging from information concerning unique events to universal information). Reports from centers of local activities play an important role. For local events do not lie outside the political sphere. Instead, they are local manifestations of political activities, even though their exact connection to overall policies may not always be evident. In such a context it is the task of political information in socialist societies to raise what is local, unique, and specific to the general level, to that of overall policies, or, in the words of V. I. Lenin, to "connect socialism and the political struggle with every local and narrow question".¹

¹ V. I. Lenin, *Collected Works*, Vol. 4, p. 281.

The following levels of generalization of political information are distinguished:

- communications concerning specific facts and events of political life;
- interpretations of facts from a class and party point of view;
- the generalization of facts, their analysis, and the identification of typical phenomena within particular areas of political activity;
- the identification and analysis of laws of behavior and stable trends within the political sphere;
- systematized overviews of the entire sphere of political activities.

At the first of these levels information contains *reports* concerning facts and events, while information at other levels contains *explanations*, *generalizations*, and *evaluations* of events. The first level provides the materials and the basis for other levels, while the latter frequently serve as a basis for searches of additional events and facts and for their interpretation.

Under socialism political information serves as an important means for achieving a scientific regulation of social development. In this most general context it is the task of regulation to bring the subjective activities of individuals in accord with the objective laws that govern the functioning and development of society. It follows that in socialist countries the principal objective of political information systems and of ideological and educational work as a whole concerns the development of a consciousness of reality among persons and of convictions that will bring about those forms of behavior that meet the needs of laws of social development and the interests of society and thus contribute to the realization of progressive possibilities. But in its role as a means of regulating persons, political information operates only gradually. In the initial stage individuals learn about a problem and acquire new knowledge. In the second, knowledge is transformed into convictions and into behavior incentives. And in the third stage, convictions are transformed into concrete activities.

The task of political information systems is thus not merely to enlighten people or disseminate knowledge, but rather

to help working people *develop deep and stable political convictions*. Only then can high ideals become incentives to comparably elevated types of activity.

In a socialist society political information serves to carry out the policies of the Party and the state, as a means of developing public opinion, to organize masses in carrying out regulation decisions, to control their execution, to control managerial activities of the agencies and responsible individuals, and to identify and overcome shortcomings. It develops a scientific, Marxist-Leninist view of the world among individuals and a communist consciousness, and serves to increase the initiative of masses in labor activities and in social activities and their involvement in social regulation. The principal function of political information under socialism is to explain the policies of ruling Communist and Workers' parties and of the state, to mobilize masses to embody these policies in their practical activities and to carry out successfully plans relating to the development of socialism and of communism.

In order that persons may be active participants in the development of a new life they must above all acquire a deep understanding of the objectives and tasks that societies face at each concrete stage of their development, act in accordance with these objectives and tasks, and solve individual problems with due consideration of social interests.

Although the regulation function of political information expresses itself in all spheres of social life (the economy, social relations, culture) it is carried out *indirectly, through the developing of consciousness* among persons, and of the norms and values that guide them in their activities. By teaching a conscious approach to work, to other persons, and to social activities, and by motivating them to undertake the activities that socialist societies require, political information contributes to achievements in the economic, social, and cultural sphere. It operates above all as a means that enables individuals to govern themselves by influencing their consciousness and behavior, and through individuals and their thoughts and activities—as an instrument for regulating social processes.

In the Soviet Union it is the Communist Party that is responsible for the political information system, and all the

components of this system—the press, radio, television, films, and verbal channels of political information operate under its direct guidance. As they communicate, analyze, and generalize facts and events, they rely on the principles of Marxism-Leninism in helping workers to orient themselves within the most complex events of social life and to develop attitudes towards those events.

Lenin's principle of democratic centralism, which is the basic one in organizing the regulation of socialist societies, presupposes exchanges of information between the center and local units. V. I. Lenin noted on many occasions that the Party's leading bodies and its Central Committee must be accurately informed concerning the activities of Party organizations, their successes and problems, their difficulties and shortcomings. At the same time, it is vital that local Party organizations be informed concerning the center's major decisions and activities.

The Party and the Government inform the Soviet Union's working people concerning its major policy objectives, corresponding decisions, and the course and outcome of their implementation. They encourage wide discussions of major documents, legislative proposals, and development plans. A wide informing of the people concerning the Party's policies form a necessary condition for their successful implementation, and for effective administration.

Similarly, access to information from local units makes it possible for the Party and the Government to be informed in a systematic manner concerning the morale and political state interests and needs of the people, their attitudes towards the Party's policies and towards Party and Government decisions, and concerning the current state of individual sectors within the country's overall development. Such information serves as a barometer, as it were, that is sensitive to changes in the moods of the people and that operates as a signal responding to events within the most diverse spheres and levels of the social organism.

Since the laws that govern the development and functioning of society always manifest themselves through the activities and behavior of individual persons and are reflected in their consciousness, the behavior and disposition of the masses of the people represent one of the reliable

indicators of the extent to which these laws are well understood and correctly employed and of the extent to which Party and Government decisions correspond to the requirements of these laws and to the interests and needs of working people. In short, political information from below is a definite indicator of the extent to which the leadership and management of a socialist society is scientifically grounded.

Mutual exchanges of information between the center and local units make it possible for local organizations to mobilize their efforts in achieving the tasks defined by the Communist Party, and to define their role within the overall efforts of the Party and the people. At the same time they make it possible for leading bodies of the Party to provide effective leadership to local organizations, to allocate their efforts, to monitor the effectiveness of decisions, and to enter adjustments into them in the light of actual requirements and of the wishes of Party members. At the same time, political information represents an important form of dissemination of successful experiences in political, economic, and cultural development.

Continuous and comprehensive information serves as an effective instrument of Party leadership and as a means for consolidating still further the Party's close ties with the masses of the people and for increasing their social initiative. It is also a persuasive measure of the comprehensively democratic nature of socialist system.

In view of the importance of a rational organization of information flows government and social organizations as well as Party organs are engaged in improving their movement and in finding more effective forms for informing the masses of the people. These include systematic addresses by Party leaders to working people, information conferences, and the publication of a diversity of reference manuals. They also include concrete sociological studies that provide guidance in prevailing situations and take into account the suggestions of working people as well as the establishment of well-structured chains of responsibility of lower level bodies before higher level ones.

There have been substantial improvements in the organization of political information in the Soviet Union in recent

years. There have been many qualitative and quantitative changes in mass publicity and information media, while the number and level of training of personnel working in the field of political information has increased. At the present time nearly one and one half million Party members are engaged in publicity activities, as well as a growing number of specialists, Party executives, members of local government agencies and of economic organizations. New and more effective forms of conveying political information are being found. These include, for example, local political information clubs. In addition problems of political information are discussed more frequently in Party committees and organizations.

At the same time, the current tasks of communist construction in the USSR, and of educating the working people, call for the further development of the political information system and for further improvements in its role in society's life and its development.

What are the factors that serve to increase the importance of political information in the lives of Soviet people and of the country itself?

Above all, they include the *increasing role of the subjective factor* in the development of socialist societies, that is of the role of conscious goal-oriented activities on the part of individuals in solving the increasingly complex and diverse tasks of communist construction. It is widely known that communism and socialism do not emerge spontaneously, but rather as a result of conscious goal-oriented activities on the part of workers under the leadership of the Party and of the socialist state. As the consciousness of persons increases, and as does the degree to which they are informed, politically convinced, and able to apply a scientific world-outlook and Marxist ideology, so does the effectiveness of communist construction.

V. I. Lenin wrote that living and creative socialism is the creation by the peoples themselves. "The greater the scope and extent of historical events, the greater is the number of people participating in them, and, contrariwise, the more profound the change we wish to bring about, the more must we rouse an interest and an intelligent attitude towards it, and convince more millions and tens of

millions of people that it is necessary."¹ It is political information that serves as the active means that increases interest in the task of communist development and stimulates politically motivated labor activities and social activities of workers.

Another factor that serves to increase the importance of political information, is the *further improvement and development of socialist democracy*. As the role of Soviets, social organizations, and workers' collectives increases a further development of democracy expresses itself in a growing transition from methods of coercion to methods based on convictions.

In this connection, V. I. Lenin observed that "...for any government that is at all democratic the task of convincing the masses ... will always be among the important tasks of government".² In the context of development of a communist society convictions serve as the most important method for influencing persons and for governing persons and social collectives, while political information is an unequalled means for convincing, educating, and organizing masses.

It is through the political information system that the principle of *openness* is applied, which is one of the essential principles of genuine democracy.

It is for this reason that the greatest possible development of openness in Party and state affairs is an important element in the further development of socialist democracy. A parochial approach to decision taking serves to reduce the level of activity of Communists and of workers. If a person cannot find an answer to a question that concerns him or hears a reply that is either inaccurate or that avoids the main issue he may soon become indifferent. An informed person, on the other hand, is able to act purposefully, consciously, and with confidence. Naturally, persons are primarily interested in decisions. But they are also extremely interested in the methods of arriving at decisions; how issues arise, what arguments are advanced both in favor and against a particular decision and what are its grounds. Political informa-

¹ V. I. Lenin, *Collected Works*, Vol. 31, p. 498.

² *Ibid.*, Vol. 42, p. 68.

tion provides an effective means for maintaining and extending the principle of open discussion in Party affairs and in the governing of society generally. In this connection L. I. Brezhnev has noted that "openness, the informing of masses of the Party and of all workers concerning Party activities is one of the principles governing our Party life and we rigorously adhere to that principle".¹

The revolution in science and technology is still another cause for the growing role of political information. This revolution is taking place in countries possessing different social systems. It is used in pursuing different objectives and produces different socio-political and ideological consequences. At the same time that it brings the greatest gifts to man and untold possibilities, it also carries with it immense dangers and under capitalism its achievements are often employed in ways that are harmful to people, rather than beneficial to them. To possess only scientific and technical knowledge is by itself insufficient in order to place the latest achievements of science and technology at the service of man and of socialist society, to merge them with the organizational forms that are specific to socialism, and to take into account its diverse consequences. It is also necessary to prepare man politically, in terms of his view of the world, as well as morally, to work in the context of the revolution in science and technology. Political information is an effective means for achieving this.

As development towards communism proceeds the education and skills of Soviet people increase, as do the intensity of their labor activities and social activities, their needs and interests, and especially, their interest in the Party's domestic and external policies and in the realization of these policies. That interest can be largely met through a continuous improvement in the political information system.

Finally, the role of political information also increases as the *international ideological struggle between socialist ideology and bourgeois ideology becomes more complex*. Political information equips Soviet man with knowledge that

¹ L. I. Brezhnev, *Leninskim kursom. Rech i statii* (Following Lenin's Course: Speeches and Articles), Vol. 2, 1970, pp. 200-201 (in Russian).

enables him to successfully oppose the influence of foreign ideals and to wage a successful struggle against bourgeois ideology and revisionism.

2. REQUIREMENTS THAT SHOULD BE MET BY POLITICAL INFORMATION

The most important requirement is that of a class-oriented and Party objectives-oriented approach to political interpretations. This means that communications concerning phenomena and processes of social life should be seen from the point of view of the interests of the working class, of the working masses, and of the objectives, ideals, and tasks of the Communist Party.

V. I. Lenin has observed that a class-oriented and Party objectives-oriented approach requires that one "pursue *our own* line and combat the *whole line* of the forces and classes hostile to us".¹ This requirement has become especially relevant today, when an irreconcilable struggle between two ideologies is taking place in the world—the socialist and the bourgeois ideologies. Especially today there is a need for careful approaches to information in terms of basic principles and a rigorous orientation on Party objectives.

Having experienced cruel defeats in political struggles, including armed political struggles, and experiencing a succession of defeats in its economic competition with socialism, imperialism is now relying primarily on a struggle in the field of ideology and is engaged in an active offensive on the ideological positions of socialism. The objectives of that ideological offensive include a defense of the capitalist order and attempts to make its fading edifice more appealing, to keep the masses of the people under the hold of bourgeois ideas, and at the same time, to blacken the image of socialist formations, to disprove Marxism-Leninism, to arouse distrust towards the ideas of communism and towards the political objectives of socialist countries.

The political leaders and theoreticians of imperialism

¹ V. I. Lenin, *Collected Works*, Vol. 14, p. 343.

view it as their main task to bring the ideological struggle directly onto the territory of the USSR and of other socialist countries, to influence the consciousness of citizens of socialist countries, and to introduce ideas and principles that are foreign to the new social order and to the socialist way of life. They place particular hopes on making use of vestiges in the consciousness of individuals, of nationalistic and religious prejudices, individualism and greed, a striving to live on the basis of non-labor incomes, vanity, envy, avarice, and a worship of money or material goods.

The struggle against bourgeois ideology has become even more important because the network of channels for infiltrating bourgeois ideology into socialist society has now become wider. Each day Western radio stations devote many hours to the transmission of propaganda materials that contain vicious attacks on socialism, a variety of forms of gossip, subtly veiled lies, and praises of bourgeois society.

It is true, of course, that bourgeois ideology is no longer able to develop ideas that could attract wide masses of the people and engage their hearts and souls. Because it expresses the interests of a class that is leaving the historical arena it is an ideology without a future. Bourgeois ideology is rent by fear, uncertainty concerning the future, and the confusion produced by the complex labyrinth of social events. Its destiny is to struggle against progressive lines and leading social thoughts rather than to be creative.

At the same time, it is not permissible to underestimate the influence of bourgeois ideology, as well as of revisionism, which objectively serves to assist it. The Communist Party of the Soviet Union considers that it is its duty and one of its most important responsibilities to actively oppose attempts to introduce views that are foreign to the ideology of Soviet society, and to develop in each Soviet person firm political convictions, ideological stability and an ability to oppose any forms of bourgeois influence.

Opponents of socialism frequently reproach the Communist Party for having monopolized the system of political information, and beyond this, all ideological activities. Yet, to play the role of a leader in that important field of social life, is both a right of the Party and a duty. Because the Communist Party is a ruling party, its mission is to provide

leadership in all the spheres of the socialist society including the ideological one. It has won that right through persistent struggle and devoted work jointly with the working class and the entire people, providing leadership in serving the interests of the people. The Party's ideology, Marxism-Leninism, which has assimilated a large heritage of wisdom and the experience of working masses, has been accepted consciously and voluntarily by the people. Accordingly, the principle of considering developments from the point of view of Party objectives and the defense of the Party's policy and ideology also represent a defense of the people's most important ideas and interests of its present and its future.

The aim of the Soviet people and of the Communist Party is the achievement of communism and a comprehensive support to those forces which are struggling against capitalism. Accordingly political information is intended to serve that task.

The aim coincides with the objective course of history and the movement of mankind from capitalism to socialism. This is the basis for the intimate association between the requirement for an orientation on Party objectives and the scientific character of political information. The *scientific character of information* presupposes that it corresponds to the needs of objective regularities governing the development of society, to its generalized and systematic character, and to a coordination of its different streams and channels. The scientific character and objective nature of information constitutes a necessary attribute of its reliability, which is itself a necessary condition for a scientific regulation of society.

The scientific nature and objective character of political information under socialism is provided by its intimate association with life itself, and with the practical aspects of revolutionary struggles and of socialist and communist construction. The scientific nature of that information results from the fact that its methodological and theoretical basis is Marxism-Leninism, which represents a guiding principle within the very complex labyrinth of information concerning phenomena and processes in social life, and which makes it possible to identify within these phenomena and processes

the regularities that govern them and the trends in social development that are progressive.

Political information is incompatible with various types of illusions, with voluntarism and subjectivism, with false pride and empty words. "Less political fireworks," wrote V. I. Lenin, "and more attention to the simplest but living facts of communist construction, taken from and tested by actual life—this is the slogan which all of us, our writers, agitators, propagandists, organizers, etc., should repeat unceasingly".¹

There is probably nothing as harmful to the consciousness and behavior of man as subjectivism, a tendency to simplify life and to construct unreal objectives that do not follow from available possibilities and are therefore unrealizable, and the absence of order and organization. All this serves to disorient and disorganize the activities of individuals and produces a superficial attitude with regard to one's responsibilities towards one's collective, society and leaders. And conversely; it is difficult to overestimate the favorable influence of truthfulness and realism in information, of its scientific character and correspondence to the facts of life. That type of information develops a sober and thoughtful approach to the world, a high feeling of responsibility, and a quiet confidence.

Truthfulness thus appears as a necessary requirement towards political information. V. I. Lenin would say that "our propaganda and agitation must be open and above-board".² The truthfulness of information is a condition for developing confidence on the part of the masses of the people towards the Party and its policies and is an important means for increasing the creative activity of masses and fostering a feeling of general and personal responsibility which is in many ways developed by a clear understanding of the realities and of actual problems.

Truthfulness in information presupposes its correspondence to the actual state of affairs and a reflection not only of the achievements of socialism, but also its shortcomings, difficulties and mistakes. One of the important moving forces

¹ V. I. Lenin, *Collected Works*, Vol. 29, p. 419.

² *Ibid.*, Vol. 32, p. 215.

of socialist society is criticism and self-criticism, which makes it possible to identify contradictions and difficulties in its development and to find ways for overcoming them. But in such a context one should not omit what is most important, namely, the very large advantages of socialism and its achievements in all spheres of social life. One should not lose sight of determining trends and perspectives in the development of society, should not sacrifice the principles and ideals of socialism and communism and should not lower oneself to the level of criticizing for the sake of criticism. That is the problem. Political information must develop pride among Soviet citizens in their country and their people, together with a readiness to selflessly defend the achievements of socialism.

This does not mean, of course, that political information should side-step sharp and complex issues pertaining to internal development and to the international situation. Such an "ostrich policy" produces great harm. For persons who do not receive comprehensive explanations of problems that concern them continue to search for an answer and may "find" it either in bourgeois sources of information, or else, among domestic demagogues and skeptics of various types that continue to exist in our environment. Thinking about life and attempts to find answers to urgent and difficult problems arising in the course of life is a normal expression of man's curiosity and of his striving to understand the world and society and to penetrate into the essence of social events. It is well known that man is by no means always inclined to accept prepared recipes. Accordingly instead of offering prepared formulas for all situations that may arise in life, it is appropriate to present particular conclusions with logical arguments and in some detail, yet without imposing specific views on others.

The scientific character and truthfulness of information is intimately associated with its *concrete character*. The cause of communist education cannot be served by information generally, without regard to specific conditions, places and times, but by information that is "associated" to a concrete stage in the development of socialist society and to concrete tasks and specific channels and individuals within the audience. Stated briefly, the essential requirement of

concreteness in processes of political information is to identify *when to inform, as well as where, whom, and how*.

Ways of thinking and the behavior of people develop as a result of the influence of objective conditions, as well as of a subjective factor, namely, conscious goal-oriented ideological work. It follows that in the organization of political information and of ideological work as a whole it is not possible to permit either subjectivism and the absolutization of subjective factors or unstructured, superficial views of the importance of ideological work, or the view that objective conditions will by themselves develop consciousness and modes of behavior of individuals that correspond to social requirements.

In our times there is a growing interest towards the internal world of man and towards his interests, ways of thinking, and feelings. And this is natural since the new society produces living rather than abstract persons in the full diversity of their living manifestations. It is the task of political information to carefully enrich this internal world of man. It is the responsibility of workers of the political information system to know well the concerns and thoughts of Soviet people and the questions that absorb them, and to provide truthful and clear answers to these questions.

In this connection, it is important to take into consideration the fact that man is not only a thinking creature, but one that is also emotional and possesses deep feelings. The sensual and emotional aspect of personality plays an important role in its perception of social ideas and of political information. This defines still another requirement, namely a combination within such information of both logical and emotional elements. This presupposes not only a deep content in terms of basic ideas, but also a clear and attractive form that is able to arouse lofty feelings and emotions in men. Information must reach not only the mind but also the hearts and the souls of men.

Yet persons differ in terms of their age, education, cultural level and way of thinking and character, as well as with regard to the content and number of tasks that they confront. This means that information must be *differentiated* in nature. The task is to inform concrete living men rather than man generally or an abstract man.

As in no other type of information the elements of *relevance* and *newness* are extremely important in political information. A timely conveying of communications concerning the latest events in the country and abroad makes it possible to solve particular problems quickly and effectively and to develop social opinion in relation to particular events. Yet the timeliness of information does not imply that it is hurried. In fact the operational character of information always presupposes a high quality of information.

The requirement of current relevance is closely associated with the operational character of information. Persons should be informed in time and operationally not concerning events generally, and not of all kinds of events without distinction but concerning the major and the most significant events that can arouse, at a given time, the greatest measure of social interest. Naturally this refers to information containing data relating to new events and facts. The repetition of old facts, events and conclusions that are well known to all, is inadmissible in the organization of political information.

Only new information is able to arouse an interest in thoughtfulness and in following the further course of events.

3. MASS INFORMATION MEDIA

The term "mass communication media", which refers to newspapers, periodicals, radio and television, is used relatively widely in the literature. In our opinion its use in such a sense is insufficiently justified. Communications (from the Latin, *communicatio*) refer to messages and means of communication. Radio, the press, and television, however, are not merely means of communication. In fact, such a definition leaves out the content aspect of their operation, while it is precisely the contents and the objectives pursued that are the main element. V. I. Lenin referred to the press as being a collective propagandist, agitator, and organizer.

This description is fully applicable to television and radio as well. It will therefore be more accurate to refer to the press, radio and television as means of mass information.

The press, radio and television are extremely powerful means that are probably not equalled by any others for in-

fluencing individuals, their consciousness and behavior, their work, life and way of living. In fact their role is so considerable that one occasionally hears assertions to the effect that they constitute the very basis of social life and of all social transformations.

It is the view of the French journalist J. Cazeneuve, for example, that "in our times, a transformation of social life is taking place with the help of most modern means of communication".¹

While it is not possible to agree with such an assertion, there is, nevertheless, no doubt that the press, radio and television serve as the population's principal sources of information, particularly with regard to political information. A survey carried in 1968-1970 in the city of Taganrog, for example, indicates that 80.3 per cent of persons interviewed, received information from mass sources, 5 per cent received such information from conversations with fellow workers and friends, and 14.9 per cent received it from conversations with relatives.²

Similar findings were provided by many other surveys in the USSR.

Bourgeois ideologists have sought to show that the press, radio and television are merely impartial channels for conveying information that are indifferent with regard to its contents and to the objectives that are served by providing information. They frequently employ the term "mass communication media", in order to emphasize such an educational role on the part of means of mass information that lies above individual class interests. In fact, however, they constitute the essence of an organization that lends to information a specific class content and serve as channels for carrying out the policies of the class that controls these means.

In capitalist society the means of mass information are owned by the largest monopolies. Ninety-five per cent of the daily newspapers in the USA do not have any competitors,

¹ J. Cazeneuve, *Les pouvoirs de la télévision*, Paris, 1970, pp. 11-12.

² See *Problemy nauchnogo kommunizma* (Problems of Scientific Communism), 5th edition, Moscow, 1971, p. 336 (in Russian). (Some of the respondents have mentioned several sources of information.)

since after crushing their rivals they have become the only ones in their city, county or state. Beyond this, more than one-fourth of the newspapers and journals published in the United States are published by five cartels, namely, Hearst, McCormick-Patterson, Scripps-Howard, Newhouse, and Knight. Similarly three monopolies, namely, Asahi, Mainichi, and Yomiuri account for more than one-half of the circulation of Japanese newspapers, while in the Federal Republic of Germany, 40 per cent of the daily newspapers and 80 per cent of the Sunday editions are published by A. C. Springer, and in Britain, four newspaper trusts control 99 per cent of the total mass-circulation popular press.

Such publications yield enormous and continuously increasing profits. The overall revenue of the five largest publishing houses in the Federal Republic of Germany in 1956 was 150 million marks and this rose to 955 million in 1966. In Britain the latest rate of profit on investments in the publication of newspapers and journals was 20-30 per cent, that is twice as much as the average rate of profit in the printing industry.

It is natural that mass information media serve loyally their masters, namely, monopoly capitalism. While the West's ideologists have much to say and to write concerning freedom and democracy, concerning freedom of speech and the independence of the press, in fact, freedom of speech in the bourgeois world is as illusory as are many other types of bourgeois freedoms. It is freedom for those who possess capital and power. The French journalist B. Vuyenne, for example, observes that the monopolization of the press has led to a situation in which "the consumer is deprived of freedom". "The assertion that the market for the press is open to all suggestions, and that, accordingly, freedom of choice is practically unlimited, is equally false."¹

Similarly, H. Meyer, the Federal Republic of Germany, writes that as soon as a number of newspapers are published by a single publisher, there arises the danger that at some point they will begin to be guided by a single political will, namely, by the will of their publisher. Thus, the creation of

¹ B. Vuyenne, *Le Droit à l'information*, Paris, 1970, p. 72.

trusts may have as their outcome a limitation on the diversity of information. It may even influence the freedom of political activities of parties.... Large press trusts are also in a position to impose their will on other publishers. Because they use more modern technical equipment and possess greater financial means, they may easily win in a competitive struggle with small, or else, medium-sized publishers. In many cases it is sufficient for a powerful concern to merely threaten such a struggle in order to force weaker organizations to make concessions.

In modern capitalist society the manipulation of public opinion and of the consciousness and behavior of individuals has become an accepted means of state policy. Such acts of manipulation serve the objectives of subordinating the majority to the minority and of preserving the system of private property and exploitation.

In describing the essence of this type of manipulation the West German sociologist, Gustav Faber, writes in the study entitled *The Manipulated Majority* that magicians rely on tricks. In our time, however, political and economico-political as well as cultural-political manipulators also rely on tricks. In that sense magicians and managers of manipulation are not very different from each other. But magicians work for the sake of a game of entertaining and of deception as an end in itself. Manipulators in modern organizations, however, independently of the sphere in which they work, operate quite seriously and in a dedicated way. For they create power. Power over those who are manipulated. Faber adds that manipulation represents the most refined form of dictatorship.

The most effective means of manipulation are mass information media, namely, the press, radio and television. C. Friedrich, an American political scientist, writes that these means are instruments "to manipulate men in relation to the political order, to make them support it, or at least not to oppose it, whether these men be citizens or foreigners...."¹

It is widely known that a person assimilating information

¹ Carl J. Friedrich, *The Pathology of Politics*, New York, 1972, p. 176.

possesses certain stereotypes in thinking. Such stereotypes represent stable and usually simplified images and conceptions concerning specific or else, negative events, phenomena, persons, etc. They are developed as a result of a repeated emotional and logical emphasis within the person's consciousness on particular aspects of events and facts, and on a repeated perception of that event or else of information concerning it. Stereotypes often encompass traits that are most visible and evident, rather than essential traits. Evaluations of events that correspond to stereotypes are often accepted without proofs and are felt to be the most correct ones, while other evaluations are subjected to doubts.

Mass information media represent a powerful instrument in developing stereotypes. This feature of mass information media is employed by bourgeois propaganda, which develops within the consciousness of persons stereotypes that correspond to the interests of the ruling bourgeois class.

The principal manipulatory mechanism that is employed by the mass information media is a veiling of reality and above all, a veiling of the class character of capitalist societies. Wide use is therefore made of such concepts as "social partnership", and "pluralistic society". Social events are personified. Major socio-political problems are reduced to an analysis of the personal qualities of political leaders, of their interests, and their miscalculations and errors. Social conflicts are interpreted as conflicts of personalities. Mass information media serve as the major channel of mass culture, which serves to divert the attention of the masses of the people from problems of social life.

In order to create the appearance of objectivity the bourgeois press, radio and television often describe the shortcomings, conflicts, and the less attractive sides of capitalism. The foundations of that structure, however, are never subjected to any criticism. In that connection the West German sociologist T. Adorno writes that "the ideals of conformity and accommodation were inherent in popular novels from the very beginning. Now, however, these ideals have been translated into rather clear-cut prescriptions of what to do and what not to do. The outcome of conflicts is pre-established and all conflicts are mere sham. Society is always the

winner, and the individual is only a puppet manipulated through social rules."¹

The misrepresentation of socialism and of socialist way of life, as well as of the internal and international policies of Communist parties and of socialist countries plays an important role in bourgeois propaganda. "Liberal", "humanistic" conceptions of socialism associated with bourgeois or revisionist views are contrasted to actually existing socialism which is described as "harsh", and "unfree".

The arsenal of means that are widely employed by the press, radio and television of the bourgeois world includes a low-level sensationalism, streams of vulgarity, erotics, a dwelling on violence and crime, a failure to report events that deserve attention, misinformation and libelous assertions, standardization and tendentiousness, cheap stereotypes, all kinds of rumors and gossip, and prolonged polemics concerning trivial events and scandalous accounts. And behind this variegated flow of words and images one may clearly discern the underlying class tendency, namely, to defend the world of private enterprise and to drown in facts and details which may occasionally be interesting and absorbing, the actual reality and the deep problems and contradictions that are currently shaking the contemporary capitalist world. Accordingly it is not surprising that the Italian journalist, Arrigo Benedetti, writing in the weekly *Mondo*, chose to preface his comments concerning the position of journalists in the capitalist world with the expressive title "We Are Slaves".

Such is the state of affairs with regard to "non-partisan" information in bourgeois society.

In a socialist society mass information media belong to the people and serve the people and the cause of communist construction. They are Party objectives-oriented and class-oriented, since they express the interests of the working class and of all workers. They are Party objectives-oriented since they serve as channels of implementation of Party policies and as elements of the organization of masses for the carrying out of such policies. They are Party objectives-

¹ T. Adorno, "Television and the Pattern of Mass Culture". *Mass Communications*, University of Illinois Press, Urbana, 1960, p. 600.

oriented, since the ideals and policies that orient them are defined by a Communist Party.

In socialist societies the press, radio and television cannot be and must not be a means for expressing personal dispositions, subjective opinions and errors on the part of journalists, and as a means for disorienting readers, listeners, and viewers. Creative thoughts, discussions, and searches are, of course, necessary, but they must be channeled above all towards constructive solutions of problems. Freedom of the press, as any other freedom, is not some kind of abstraction in socialist societies that is distinct from specific historical conditions and class criteria. It is a freedom in the context of socialism and of its fundamental principles, norms, and requirements.

The CPSU gives much attention to the development of mass information media, to further improvements in the forms and methods of both their operation and their management by the Party, and to the training and education of Soviet journalists. This is illustrated by resolutions of the Central Committee of the CPSU entitled "Improving the Effectiveness of the Soviet Press", "Increasing the Role of District Newspapers in the Communist Education of Workers", "Improving Soviet Radio Broadcasting", "The Further Development of Soviet Television", "Further Improvements in Guiding the Mass Movement of Factory and Rural Correspondents of the Soviet Press", and "The Further Development of Voluntary Forms of Participation in the Soviet Press and Radio".

The efforts of the Party and of the Government have made it possible for mass information and mass propaganda media to develop very rapidly in the Soviet Union.

Television broadcasts encompass approximately 200 million persons, and the most important television programs reach 150-160 million viewers simultaneously. There were 130 television centers producing their own programs in the USSR in 1974. In addition to receiving Union-wide programs they also initiated their own broadcasts. Within the national republics programs are broadcast in the national languages.

There are more than 57 million radio receivers and 168.5 million speaker units in the Soviet Union. Radio broadcasts are made in 70 languages of various peoples of the world,

The scale of press activities is enormous. Some 8,200 newspapers and 7,000 journals and other publications of similar types are published in the USSR. In 1974 they published 147.3 and 158.6 million copies of each issue respectively. The circulation of the newspaper *Pravda* is more than 10 million copies, and is nearly 200 times larger than the circulation of all newspapers published in prerevolutionary Russia. Newspapers are published in 58 languages that are spoken within our country, including 18 languages of peoples that did not have their own script before the October Revolution.

Similarly, the number of books that are published is very great. During the years of Soviet power more than 2.4 million titles of books and booklets were published with a circulation of 38 billion copies. Literature is being published in 145 languages, including 89 languages spoken by peoples of the USSR and 56 languages spoken by peoples in other countries.

There exist definite distinctions between different types of mass information media, each of which possesses specific characteristics and advantages in relation to others. Radio and television for example are unique in their capacity to function in an operational manner and to inform individuals directly from the scene of events. While newspapers and especially journals and books are less operational in such a sense, they are more comprehensive and possess a greater capacity for analysis, generalization and comments concerning events. In addition, the information that they contain may be recorded, used repeatedly, and compared with new information. All such media, however, possess a common characteristic, namely, their use of *mass channels* and their capacity to serve a very large and practically unlimited number of persons. It is this which makes mass information media a powerful instrument for influencing the minds and hearts of large masses of people.

All mass information media also perform specific common functions. These are listed by G. I. Khmara as the following:

a) an *information* function, which conveys a flow of information concerning the economic, political, social and spiritual development of our country, of the socialist system and of other countries in the world, including capitalist countries;

b) an *enlightening* function, which provides for a dissemination of a complex of knowledge concerning various fields of science, technology, culture, and art;

c) an *educational* function, which contributes to the development, in the audience, of a scientific view of the world, a deep conviction with regard to ideals, and a public opinion; this is a function that influences the general mood of the masses of the people;

d) a *regulation* function, which directs the energy and efforts of working persons towards achieving the objectives that society confronts;

e) an *hedonistic* function, through which particular information produces satisfaction or pleasure among members of the audience. That function contributes to a better assimilation and remembering of information and influences the behavior of individuals and of groups of persons.¹

The principal functions of mass information media are the *political-educational*, *propaganda*, *regulating*, and *organizing* functions. They bring to the awareness of individuals the essence of the Party's and the state's policies and of administrative decisions, provide guidance within a very large number of social events, indicate and comment, enlighten and convince, recommend and appeal, motivate and organize masses, develop social opinion, and introduce a system of social values and patterns of behavior. They also serve as a means for establishing the attitude of masses towards Party and Government decisions and events within the country and abroad, and as channels for communicating proposals and critical comments as well as signals concerning the functioning of different levels of the social organism and of different administrative bodies and levels of leadership.

Mass information media play a large role in raising and elaborating important economic, socio-political, scientific and technical and ideological problems and direct the attention of listeners, readers and viewers towards those that are more important, "inviting" them to participate in their solution. They do not merely record events and observe the state

¹ Cf., G. I. Khmara, "*Pechat v sisteme massovykh kommunikatsii*" (The Role of Publications Within a Mass Communication System), *Problemy sotsiologii pechati* (Problems in the Sociology of Publications), Series I, p. 188.

of affairs but actually participate in events and guide their course in the interests of society.

V. I. Lenin noted that organs of mass information must be organically linked to life, the practical affairs of socialist construction and the creative labor of the people. He wrote that the press must devote most space to the "labor front, production propaganda, the training of workers and peasants in the work of administration, to seeing that Soviet laws and measures established by Soviet institutions are given due effect, and to an extensive and properly organized exchange of opinions with the rank-and-file reader".¹

Mass information media play an important role in helping individuals to acquire socially accumulated experience in production and in the socio-political and spiritual spheres. They contribute to the assimilation of norms and rules associated with the socialist way of life, and of social values and guidelines that help think and act in accordance with social requirements. This represents an important manifestation of the administrative and regulating function of these media.

The transmission of information among mass channels is more than a mere "broadcasting" of particular news. It is a creative process that encompasses the acquiring, filtering, and processing of data, and a selection of forms that contribute to its rapid and firm assimilation. In such a context mass information media carry out a search and filtering of socially significant information and above all, of political information, organize it, convey it to the user, and take into account the response of users to such information. They convey to wide masses of the people not only political information, but also artistic, scientific, and other information. Yet, their primary aim is to disseminate political information. Other types of information are inevitably selected, analyzed and presented from a class-oriented and political point of view.

From a wide diversity of information, the press, radio, and television carry out a purposeful goal-oriented selection of socially significant information that is able to contribute to the development of progressive social processes that channel

¹ V. I. Lenin, *Collected Works*, Vol. 31, p. 405.

the movement of socialist societies in accordance with norms adopted in programs and plans. Of course, it is through individuals that information contributes to social progress, namely, through those individuals who embody it in their activities and behavior and in new forms of regulating production, society, the organization of labor, and in new technology.

Mass propaganda and information media convey to the wide masses of workers of socialist countries the decisions of these countries' ruling parties and governments concerning various problems of economic, social, and cultural life, as well as addresses by Party, government and economic leaders. They disseminate and draw attention to the labor achievements of workers, peasants, and intellectuals; study, generalize, and disseminate experience with new methods; and report on the course and outcome of socialist emulation. They are engaged in major efforts in educating persons, increasing the level of their general education and of their cultural and technical education, and in acquainting them with new developments in science and technology. Discussions are held in the press as well as on the air concerning a diversity of issues and problems, and concerning various proposed alternative solutions. Proposed Party and Government decisions as well as legislations are also discussed.

The press, radio, and television play an important role in overcoming negative phenomena, vestiges of the past in the consciousness and behavior of individuals, and shortcomings and omissions in particular areas of development. In a certain sense they constitute the arena within which the criticism and self-criticism take place that operate as one of the important moving forces in the development of a socialist society. As a result, aside from contributing to the course of progressive processes, mass information media also place obstacles in the path of negative processes.

Thus, under socialism, the social information and especially the political information that is transmitted along mass communication channels enters into social processes by serving individuals as guidelines to action and as reference norms that direct their thoughts and activities into the channels required by socialist societies. The influence of information on persons and hence on social processes increases in

effectiveness and significance depending on the extent to which it reflects the historical process scientifically. Similarly, it increases when it meets the interests of society and of users of information more effectively and when it is successful in conveying emotions and is systematic and original. It goes without saying that an important role is played by both the level of education of personnel and the technical state of mass information media.

Mass information and mass propaganda media transform information concerning the most diverse events in social life into well-ordered streams and select the conceptual framework that is needed in order to communicate with the information user on a common wavelength and to select appropriate frequency, form of communication, and volumes of information material.

The effect that is produced by information depends on its sources and on the intermediate agents that transform it and convey it to users, as well as on the users of information themselves. It is only when sources of information are reliable, when intermediary agents are skilled, trustworthy and competent, and when the users are themselves actively interested in the information that it is possible for information to become effective and to serve as a powerful instrument in governing social processes.

While the volume of information that may be transmitted along mass communication channels is enormous, the capacity of individuals to process information is limited. This makes it necessary to present information in *doses*, and to differentiate it in accordance with specific properties of individual groups of persons and their interests and needs. It is hardly appropriate, for example, when newspapers, radio, and television duplicate information and repeat many times items that were already communicated, shown, printed and commented upon. Each newspaper, journal, and book and each radio or television program should have a precise address, and their own readers, viewers and listeners. It is only when this condition is taken into account, that it is possible to ensure the effectiveness of the mass information media.

Local themes and topics are needed, particularly in the case of information that is conveyed through mass communication channels. This refers to events concerning a partic-

ular city, district or village. For local events constitute the prism, as it were, through which general social information is refracted before it is consolidated in the form of specific values, needs, and norms in the consciousness and behavior of individual persons. On the other hand, one should also avoid an excessive emphasis on local topics since this contributes to the development of negative attitudes among persons such as local and sometimes nationalistic attitudes.

Mass information and propaganda media require a specific lag between the time at which a particular event occurs and the time at which information about it is received by consumers. This gap may vary in length and may be due to a variety of circumstances, including delays in receiving the communication by the information body itself, delays in processing information and in transmitting it, the unavailability of non-engaged communications channels (television or radio time, or space in newspapers), the operation of information thresholds, and technical causes. In all cases the problem is to reduce to a minimum the gap between the time at which events occur and the time at which information about it is received by consumers.

Exchanges of information along *interpersonal channels* represent a definite complement and continuation of information movements along mass communication channels. They are based on direct bilateral personal contacts that are associated with the transmission of unofficial types of information. In such cases the relevant means of information exchanges are speech and the spoken word. Empirical studies have shown that in the course of personal contacts individuals frequently discuss information that has been communicated by mass communication channels, as well. From these channels information enters into the new interpersonal channel, thus forming a second level audience, as it were, which is partly distinct from the first one which receives information directly from the mass channels. It is precisely within interpersonal channels that the further assimilation of mass information takes place, as well as the further understanding of its essence, its evaluation, and the recording of positive aspects and shortcomings. Personal conversations constitute one of the sources of development of social opinion.

Interpersonal information channels represent a definite mediating link between mass information and individuals. Frequently it is at this level that general ideas, slogans, appeals, and principles are translated into the specific language of thoughts and then of activities of individuals.

One of the features that characterizes informing through the press, radio, and television, is that unlike in the case of personal contacts, for example, the range of feedback relations is reduced in such cases, while the delays associated with such feedback processes are greatly lengthened. And indeed, in the presence of direct contact between an informing person and that being informed, the former is able to acquire a definite impression concerning the effect of a lecture, talk, or conversation, and may immediately adjust and correct his communication in order to achieve a greater measure of assimilation of the information being communicated. In the context of such feedback relations group discussions are especially effective, as well as seminars, colloquia, conferences and other forms of collective information and ideological work.

In cases in which mass communication channels are employed there is no live contact with the consumers of information, and for that reason it is practically impossible at each moment in time to catch the actual effect that is produced. The interest, attention, response, and wishes of the audience, their attitude to what has been said or shown, or else printed, remains outside the field of vision of the informing person or body. The corresponding forms of feedback relations include letters, telephone calls, and conferences of readers, listeners and viewers. These are received not for all communications (articles, broadcasts, etc.) and not always in a systematic manner as well as frequently with a delay. As a result, feedback relations do not operate as effectively as in the case of direct live communications between those who inform and those who are being informed. At the same time, these forms of feedback relations serve as a signal for introducing corrections in future information activities, rather than in performed ones. It is also important to note that such forms of communication with the audience are irregular in nature and often altogether accidental so that they cannot provide a full or comprehensive image.

Replies, letters, telephone calls of consumers are not representative in relation to the entire population. This makes it necessary to develop artificial feedback relations such as organized meetings with users of information and the use of questionnaires.

Consumers enter into direct communication with information only as it leaves corresponding channels. They are not able to influence the nature of the information, its selection, processing, and the speed and time of its transmission. Similarly, consumers are able to select suitable sources of information. From the great number of newspapers, journals and several radio and television programs, they are able, however, to select those that correspond most to their interests and needs. Mass information media workers must therefore strive to engage the attention of readers, listeners and viewers, and to develop their own population of consumers that should be as wide as possible. And this may only be achieved through presenting high-quality information possessing depth of content as well as vividness, accessibility in form, and timeliness in presentation.

It is also important to study the particular group of consumers that are being addressed and their interests and strivings in order to meet these interests more fully, and also to educate consumers and develop their taste and an interest in socially significant information.

In recent years there have been significant increases in the number and quality of studies of mass information media in the USSR and other socialist countries. This is partly due to their increasing role in the life of society, and partly to the efforts of workers in the field of press, radio and television to improve the quality of their work and to retain and expand the groups of readers, listeners and viewers that they are serving. This second task is quite complex and difficult since individuals are acquiring a larger choice of newspapers and journals and radio and television programs.

It has already been noted that the press, radio and television possess their own specific features which should not be neglected in the organization of information through mass information channels. The problem is not to replace one channel of information by another, but rather to define the place of each within a system of mass information me-

dia in ways that take into consideration the specific characteristics of each, as well as to study and to utilize their possibilities more fully, and especially to coordinate their work skilfully by supplementing individual channels with others. Radio broadcasts are primarily able to inform, while television shows and the press explains. And all of them taken together convey the truth to people and make it possible to learn, see, and understand the very complex phenomena and processes that are taking place in social life.

The 25th Congress of the CPSU noted that as a result of the continuous efforts of the Party and its Central Committee to heighten the ideological level of the mass media, to enhance their coordination and quicken their response to events, they have become more effective in influencing the development of the economy, science, culture, and the life of society in general. The Congress called on all organizations of the Party to provide concrete daily guidance to the press, helping further to heighten its ideological level and to make its influence still more effective.

4. THE IDEOLOGICAL PROCESS AS AN INTERACTION OF INFORMATION

In socialist societies the ideological process refers to the introduction of a socialist awareness and of Marxist-Leninist ideology into the consciousness of workers and of each individual person.

The ideological process is a complex one possessing many layers. It is a process of *education*, since it brings to the object of education knowledge concerning socialist ideology and world views that are needed by man in his intellectual and material activities. It is a process of *training* in which knowledge is transformed into individual convictions and in which communist ideals and principles of communist morality are developed within the consciousness of individuals. It is also a process of *organizing* individuals for the practical embodiment of the ideals of communism and the solution of practical tasks that arise within individual parts of socialist and communist construction. It is important to emphasize that all these aspects and directions of the

ideological process are organically linked to each other. W. Liebknecht, the veteran German Social Democrat, described ideological work in the following words: to study, to propagate and to organize.

Socialist ideology was created by Marx, Engels and Lenin. It is continually developing through the efforts of individual Communist parties and of ideological and scientific workers on the basis of a generalization of the experience of revolutionary struggles against capital and of the experience associated with the building of socialism and communism in the USSR and in other countries, as well as on the basis of the achievements of scientific thought. Taken by itself this ideology is not able to transform reality. It becomes an immense material force only when its principles and tenets gain power over millions of workers. As has already been noted, ideology is the principal component element of political information.

In order to carry out the ideological process and the process of introducing a socialist social consciousness to the individual consciousness of each member of society, a subsystem of *informational-ideological institutions* is required which represents the bodies and organizations to which an ideological function has been assigned and which are carrying out a communist education of workers. This includes the corresponding divisions within Party and government bodies and social organizations, together with the specific forms of ideological work that they carry out, namely, the system of political education among Party members, the system of political education among young people, the bodies, agencies and organizations that are concerned with mass propaganda and information media (radio, television, and the press), and scientific institutions with ideological functions.

The Communist Party of the Soviet Union defines political lines within the ideological processes and carries out a *political leadership* in ideological work. The Party formulates general ideological tasks that take into consideration the needs and possibilities of society. It also organizes and coordinates the work of informational and ideological institutions and channel their efforts towards a common objective. It also recruits, trains ideological workers and updates their skills.

The *propagandist* is the immediate subject of ideological processes and the source of ideological information. It is he who either directly in the course of live communications with objects of ideological activities (individual persons, or else, groups of persons and audiences), or indirectly (through technical means) influences the consciousness of individuals by communicating to them information of an ideological character. The successful outcome of ideological work depends decisively on the extent to which propagandists are well prepared in both a theoretical and methodological sense, on their maturity in the field of ideas, and on their personal convictions in the truthfulness of the ideals of communism, in the correctness and rightfulness of the policies of Communist parties, and on their sense of responsibility for the task that has been assigned to them, as well as their ability to approach persons and influence their minds and hearts. V. I. Lenin observed that "no control, no curricula, nor anything of that sort, can make the studies take any other trend than that determined by the lecturing personnel".¹

And finally, it is man who is the object of ideological influence and the consumer of ideological information. It is for his sake that the informational-ideological interaction is carried out. To develop within each member of a socialist society an integrated system of views concerning the world, a system of values corresponding to the essence and needs of socialism, to elevate the everyday level of his consciousness to the level of a systematized scientific knowledge and to make it possible for each person to acquire a scientific Marxist-Leninist view of the world constitutes the essence, principal objective and task of the ideological process.

Thus the ideological process presupposes the presence of an ideology (ideological information), an immediate source (the propagandist) and a consumer (individual perceiving the ideology).

The ideological process possesses specific characteristics that distinguish it from other social processes, such as, for example, the production process. For in the case of the ideological process, there is neither an object of labor nor

¹ V. I. Lenin, *Collected Works*, Vol. 15, p. 473.

means of labor, and hence, no mechanical interaction with man. There is only informational interaction between persons who are propagandists (educators) and persons who are the objects of education. Educators influence those being educated intellectually, communicate to them and convey to their consciousness information whose content is socialist ideology, and strive to transform socialist ideas into convictions on the part of individuals and guidelines to their practical activities and behavior.

This situation is basically unaltered in the case of mass propaganda and information media—radio, television, and the press. For here, too, the role of the propagandist is ultimately assumed by individuals who are equipped with corresponding information, while the role of the persons to be educated is assumed by individuals who receive this information. It is true that in such cases, the influence on the consciousness of individuals is effected through the intermediacy of technical means rather than directly, but nevertheless, the informational character of the interaction of the subject and object of education remains the same.

While in the case of the production process there are both informational and physical interactions within the framework of an elementary "man-machine" system, in the case of the ideological process there are only information interactions in the framework within an equally elementary "person-person" system of which the first acts in the role of a source of information and an educator, while the second acts in the role of a person being informed and educated.

One of the central tasks of regulating the ideological process is to improve the information interaction between subjects and objects of information in order to convey the content of socialist ideology to the consciousness of each person and to transform its ideals into the convictions of persons for this alone makes it possible to embody these ideals into their concrete activities and behavior. This necessitates a differentiated approach to objects of education and a continuous activation of their attention in order to provide for a conscious assimilation of the information being communicated, as well as a systematic and consistent approach to the presentation of information, a logical reasoning, intelligibility, and a popular exposition.

Man, together with his consciousness, activities and actions, is the main object of informational-ideological activities. K. Marx and F. Engels repudiated the cult of an abstract man, of man generally existing outside of history. Individuals are always concrete individuals and always belong to an historically specific social system, in the sense of a socio-economic formation, class, nation, and primary collective. Concrete individuals and personalities possess definite characteristics that are common to all persons, such as a capacity to work, to think, to speak, and to perform physiological functions. At the same time each concrete individual also possesses traits that are common with those of other persons, although not all of them, but rather, only members of a given social collective (working collective, class, party, nation, etc.). And finally, specific individuals also possess their own specific traits that only they themselves possess and which characterize them as individual personalities. Individual traits may refer to the most varied aspects of a person's activity, including his skills in production activities, his education, level of culture, behavior, relation to others, age, and family status.

Let us note immediately, that the personality of individuals is described not only through traits that they themselves possess, but also by the level of development of general and especially of specific human traits. All persons, for example, are able to engage in labor activities, but the level of development of that capacity and the extent to which it is carried out in practice differs in each case. In addition each concrete person is described by a specific combination of general and particular human traits.

Thus, as objects of ideological activities, individuals always appear as specific human persons and live individuals who combine within themselves the wealth of both common and unique qualities. It follows that the forms of education of each person require an individual approach.

As concrete individual personalities men are products of their society and of the social environment within which they live and develop. An appreciation of this law of development and of its implications is a necessary but not yet sufficient condition for successful ideological activities. If one considers only the social environment, then all problems

of education could be solved in an identical way, namely, by changing the social environment thus altering the consciousness of all persons simultaneously. In fact, however, we see that there is a wide diversity of human personalities within a common overall social environment (a socialist society) and that individuals assimilate and embody particular traits of that common social environment in varying degrees.

This is primarily because the social environment itself is heterogeneous, and because it always contains a dominant present and remnants of the past, as well as shoots towards the future. In socialist societies there continue to exist remnants of capitalist societies (for example, remnants of old forms of division of labor). And while a decisive role in the development of personalities is played by socialist social relations, individuals may also be influenced by relations representing the past. This is one of the causes for the existence of vestiges of capitalism in the consciousness and behavior of members of socialist societies. Another cause relates to the capitalist environment within which socialist countries exist. The political leaders and ideologists of the bourgeois world employ all possible means (tourism, radio, television, press, etc.) in seeking to influence the consciousness of persons living in socialist societies and to rekindle within them bourgeois prejudices and views.

An important cause for the existence of many individual personalities is the fact that each personality lives and develops both within a common social environment (a socialist society) and within a "microenvironment", that is, its most immediate environment. This includes the family, school, the production collectives within which they work, and the neighborhood. It is evident that this "microenvironment" serves as a prism through which the influence of the overall social environment, including socialist ideology, operates on the individual person. In view of the infinite variety of empirical circumstances constituting the "microenvironment", given individuals who may be identical from the point of view of the overall social environment may in fact manifest infinite variations and gradations that may be explained only through a careful study of these empirical circumstances. In cases in which "microenvironments" corre-

spond to the overall social environment and "operate" in a common direction, individual personalities acquire the specific characteristics of the overall social environment and its ideals, and become bearers, supporters, and defenders of the overall social environment. In the opposite case, i.e., when for any of a number of specific reasons (such as the presence of vestiges of the past, or of backward, or else, confused elements) the "microenvironments" operate in a direction that is opposite to that of the overall environment they serve to develop traits of personality that do not correspond to overall requirements.

In socialist societies the social environment is based on social forms of property and is characterized by relations of mutual assistance among persons and the dominance of Marxist-Leninist ideology. Taken by itself and in terms of its essence it develops personalities with a high level of ideological and political as well as moral and intellectual qualities. The lives of concrete individuals in socialist societies, however, sometimes develop within collectives within which relations of friendship and comradeship do not prevail, and in families in which ideals of private property exist, as well as religious ideas and amoral forms of behavior. It is obvious that such immediate environments of individuals serve as a type of barrier to the productive influence of the social environment and develop negative qualities in such individuals.

This operates as a strong influence on the nature of ideological activities. One should not expect that the social environment, socialist production and other social relations, and the dominant ideology in society will automatically lead to the formation of a new personality. It is important to carefully study the empirical circumstances of the lives of individuals and their "microenvironments", and it is important to change that environment and to bring about situations in which they operate in the same direction as that of the overall social environment. Comprehensive, systematic and well-organized sociological studies must play an important role in helping the Party and the state as well as bodies concerned with ideological activities in studying these empirical circumstances of the life of individual personalities and in changing these circumstances.

Ideological activities also take into consideration the fact that while individual personalities are a product of their social environment, they do not dissolve within society and social collectives. Individual personalities are not merely a passive element in a social mechanism without a will of their own, but are rather its most important functional links. While persons are formed by society and social circumstances, they equally influence the formation of the society itself. K. Marx wrote that one should not forget that "it is men who change circumstances".¹

Individuals bring about the development of society through their labor, their political activity, and their will and reason, and the effectiveness of such influences on the social environment and on society increases in the course of social progress. As the historical tasks that emerge develop further and become more comprehensive, and as progress takes place in science, technology, and culture, the number of persons who participate actively in historical events increases, as does the measure of participation of individual persons in the historical process and their contribution to the world's material and spiritual culture. The creative activities of individuals are particularly large under socialism, which creates conditions for liberated labor and other activities in various spheres of social life.

Naturally the extent to which each individual person is active varies, and this depends not only on the empirical circumstances and the "microenvironment" within which he operates, but also on hereditarily acquired traits or specific anatomic and physiological, as well as psychological properties inherited from his ancestors, and also on the personal experience of the particular individual, the level of his cultural development, and his intellectual and other qualities. Specific individual personalities react to the influences of the social environment and socialist ideology actively and selectively and in accordance with their specific personal interests, needs and objectives, rather than in a passive manner.

This points to still another important task in ideological activities, namely, a consideration of specific characteristics

¹ Karl Marx, Frederick Engels, *Collected Works*, Vol. 5, p. 7.

of individual persons, and teaching such persons an active attitude towards the world and towards carrying out their social functions.

As an object of informational-ideological influences, each individual person represents a complex system of qualities that embody traits from the overall social environment as well as from the concrete environment in which he lives (his "microenvironment") and also the specific traits derived from his historical experience and his hereditarily acquired properties. Beyond this individuals are characterized by a specific measure of activity and selectivity in relation to both their general and their concrete environment and their relation to the requirements and principles of socialist ideology.

We have thus examined the essence of political information and of its role in the regulation of a socialist society. A further increase in the effectiveness of political information in the USSR and other socialist countries is being attained through a coordination of the efforts of all bodies and organizations that are concerned with the political informing of the masses, through a rational planning and organization of their work and a correct allocation of efforts and resources. These are concentrated on the most important directions that are dictated by the needs of society and concrete conditions relating to the country's development. An increased effectiveness of political information is also produced by exchanges of advanced experience, and an upgrading of the professional skills of information workers.

CONCLUSION

Man exists within a diversified world. Above all, this is the world of persons with whom he forms social groups, classes, societies, and also works, engages in entertainment activities, and rests. This is also the world of nature, of the first or natural one as well as the second, artificial, which he has himself produced. It is the world of energy, which man utilizes in his operations on objects of nature in order to obtain from them the means of livelihood that he requires. Finally, it is the world of the information that man employs to guide himself, and also in order to operate on objects of nature, to orient himself within the social world, to communicate with other persons, exchange thoughts, experience, and the outcome of his activities, and to regulate social processes.

Man receives social information in two ways. The first refers to his personal, individual experience and situations in which he receives a diversity of information from other persons with whom he communicates and from the natural and social processes that he encounters. The second way is an indirect one. It refers to situations in which in the course of education and training, through knowledge derived from written, scientific, and artistic sources and the cultural heritage of the past, he acquires information that was initially acquired by other persons, from both the current generation and earlier generations.

The direct experience of man is limited by specific elements of the external environment with which he actively interacts, or else, which he has in mind in varying measures,

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in his behavior and activities. These are the events, phenomena, and processes of the external world that enter into the sphere of his subjective responses. They are spatially limited by the range of man's receptor field. They are also limited by the specific time intervals within which he exists and is active. Similarly they are limited by each individual's particular measure of intellectual development and his capacities for acquiring, storing, and utilizing information.

Information received by men as a result of individual experience is insufficient in order to guide them and permit correct behavior within their external environment and to guide both themselves and various social subsystems.

Information that is received indirectly, however, is another matter. It is not limited either spatially or in terms of its time dimensions. Its source is the entire world, nature, society, and countless generations of individuals. It reflects the outcome of knowledge and of the practical experience of mankind, which has been accumulated in the process of historical development as well as the experience of mankind today, ranging from small-scale social collectives to society as a whole. It has recorded experience in meeting a countless number of problem situations.

In this connection it is interesting to note that—if one considers the information aspect of the development of mankind—an endless contradiction is taking place *between the continuously growing volume of information on the one hand, and man's capacity to assimilate it*. But that problem arose hundreds of years ago, rather than recently. It was discussed by Montaigne in the 16th century, and by Descartes, Spinoza, and Leibnitz in the 17th and 18th centuries.

Mankind has also found the means for overcoming that contradiction, whose effectiveness moreover, increases as progress occurs in production and science and technology.

Above all, this refers to man's selective approach to information.

It also refers to an increase in the capacity of man's memory.

It refers, as well, to an increase in the capacity of information itself.

Finally, it refers to a rationalization and intensification of information processes and to the application of increasingly

advanced scientific and technical means to work with information.

A *selective* approach to information presupposes that individuals know their field of specialization and their role within a collective and society, as well as the task that both they and society confront. It also presupposes that they are able to orient themselves in the ocean of available information and to select and skilfully utilize that information which they require and that is necessary. The possibilities for improving the orientation of individuals with regard to information are practically boundless.

Similarly, the possibilities *attaching to the memory of man and of mankind are far from being exhausted*. It is thought that during their lifetime, individuals employ nearly a tenth of their creative potential, and that only four per cent of the neurons in man's brain work actively, while those that remain serve as auxiliary sources of the brain's reliability. It is important, necessary, and possible, in principle, to increase the throughput capacity of human channels for accessing information, but at the present time, science has not been able to indicate conclusively how this can be done.

Yet man's memory is subject to training and to a constant development, and only a desire to do this as well as diligence are required. There are quite a number of persons, for example, who know many languages and are able to remember and reproduce information that they acquire with surprising precision and rapidity, as well as to carry out the most complex calculations. Psychologists believe that with the help of exercises, individuals may increase the volume of their memories by five to ten times.

In addition man's memory is improving not only in the sense that its volume is increasing, but also as a result of the development of modern methods of education and of cognition. These methods help man to orient himself increasingly not merely on the recording and remembering of information but rather on an ability to *guide himself* within large volumes of information flows and to search within them the required information in order to solve creatively problems that arise.

Large gains may also be derived from an intensification of science and of other spheres of intellectual activity. Im-

proved forms of organizing and regulating intellectual work may increase very substantially society's spiritual potential including its capacity to process social information.

As a regulation subject man is also concerned with still another unceasing "informational" contradiction, namely, the contradiction between a continual and rapid change in real situations and the corresponding emergence of real problem situations, on the one hand, and an absence of experience recorded in the form of information in meeting such situations. Beyond this, available information concerning particular situations under consideration is usually far from adequate. Consciousness lags behind existence, and changes in the world occur before corresponding changes occur in consciousness. This produces an insufficiency of information at the disposal of regulation subjects and a need for a continual education and development of intellect and continual additions to available information, particularly since the period of obsolescence of information, especially in leading branches of science, technology, and organization is becoming shorter.

In the context of an intensification and rationalization of information processes great importance attaches to *increasing the capacity of information itself* through methods associated with the epistemology and with linguistics. That task, namely, to express a maximum of knowledge within a minimum length was already formulated by Leibnitz.

Science has elaborated a system of concepts, arguments, and theories that constitute an intensification of information, and an effective means for its maximum expression within a minimum length. It is characteristic that these forms of expressing scientific information are logically interconnected, and this makes it possible to derive from them a large number of corollaries, thus increasing knowledge and increasing its capacity and content. Knowledge derived from such particular conclusions, moreover, need not be kept directly in memory and may always be derived from more general knowledge and more general information.

The number of signs employed for expressing information is also decreasing. Economic forms for conveying information are rapidly developing. These include artificial lan-

guages, models, codes, and symbols that make it possible to convey a maximum information content with a minimum volume of signs. It is well-known that the same information content may be conveyed in terms of greater or less capacity, depending on the type of signs that are employed. The measure of information capacity, expressed in terms of signs, is inversely proportional to the quantity of signs employed for recording that information.

Naturally, information capacity encompasses more than merely the quantity of information as contained in signs. Capacity is also expressed in the wealth, comprehensiveness, contents, and usefulness of information, and in the particular corollaries, applications and forecasts that follow directly from such information.

From the point of view of classical information theory (Shannon's theory) which describes the processes of transmitting messages along communication channels and the probability theory that has been erected on that foundation, the capacity and information content of a message increases in proportion to the extent to which it overcomes uncertainty. Leaving aside the contents and value of information, information theory does provide definite quantitative estimates of information capacity. The larger is the volume of information that is conveyed by a message, that is, the more elements, properties and relations in reality that it reflects, the greater will be its capacity (the greater its depth, comprehensiveness, contents).

A packing of information occurs as a result of a division of information into active and passive stocks in the course of its utilization. New information displaces large volumes of obsolete information from active stocks, thus transforming it into passive stocks. Even though the resulting volume of information may decline, its value is increased through its renovation and the addition of new data. It is true that it is not easy to separate the active stock from the passive one, particularly since the boundaries between them are mobile. Nevertheless, a rational organization of information stocks makes it possible to find required information and to reject information that is not needed. In such a context obsolete knowledge does not become generally unnecessary but is negated dialectically and is overcome through new knowl-

edge within which it is retained in a transformed, condensed and concentrated form.

The reduction of the number of signs employed in expressing information is still another way for condensing it and increasing its capacity. For this purpose, so-called minimal vocabularies are employed together with encoding and a transformation of messages and information in the new signals without changing their informational content. Similar roles are played by calculations (algorithms) and symbol systems expressing information.

There occurs a reduction process as man acquires and utilizes information. That reduction passes through several stages. The first concerns the reception of signs, symbols, and the study of relations among them as well as their transformation. The second refers to a translation of the entire information to the semantic level and thus to its cognition. Since not all information may be understood only some of the information contained in the mass of perceived signs is translated to the semantic level. The third stage concerns a semiotic reduction of information, which is associated with the selection of valuable information from the larger set of perceived information. As a result the volume of information is reduced, even though its significance and value to the user increase.

The depth and comprehensiveness of assimilation of information by individuals depends to a large extent on the qualities of the individual himself and on his concerns. In cases in which a particular information corresponds to the concerns of the individual, it will be assimilated more deeply and more comprehensively, and the principles that it contains will be transformed into the individual's own convictions and embodied into his thoughts and activities. In cases in which there is a deviation between the individual's concerns and the information, the latter is either not perceived at all, or else is perceived in a superficial manner. In this connection, it should be noted that the individual's concerns themselves do not remain constant and that to a large extent, they change under the influence of information.

Finally, there is still another way of overcoming the contradiction between the continually increasing volume of

information and man's limited memory and capacity for processing information, namely, the *utilization of scientific and technical means* and the creation of informational systems and especially of automated informational systems with the help of electronic computers. To an increasing extent, computers today serve as gigantic repositories of information and are replacing traditional archives, reference manuals, and encyclopedia.

At the present time, there exist three types of automated systems:

- systems for the regulation of equipment and technology;
- systems for the regulation of enterprises and sectors;
- systems of scientific and technical information, which are essentially information retrieval systems.

It is anticipated that in the future these systems will be integrated into country-wide information systems, required for the regulation of production activities. It seems to us that ultimately this will be an integrated information system for the regulation not only of production but of society as a whole, including its economic, socio-political, and spiritual processes.

A system that is qualitatively new is thus emerging that relies on a complex analysis of data deriving from both scientific activities and practice in order to produce information that is qualitatively new. For example, data concerning a particular technical improvement must be compared with the characteristics of mechanisms already operating in enterprises in order to calculate the advantages that the enterprise, sector, or national economy will derive as a result of that improvement, the number of specialists required for its utilization, and where they should be trained. In short, such a system will convey complex information concerning technical, economic, and social aspects of the application of technical improvements. This will be not merely technical or economic information, but specifically *scientific* information in the widest meaning of that word. It will reflect not merely the results of scientific activity (the content of books, articles, patents, etc.) but also events, facts, processes currently taking place, and constituting an object of scientific understanding.

At first such systems will be established at the level of individual countries and then, of groups of closely related countries, and finally, at the level of mankind itself.

Such an overall social system will enhance man immeasurably as a creator, bearer, and user of information, and will give him access to the totality of all spiritual treasures that mankind has produced.

Such a global information system may be viewed as an integral intellect, common to the whole of mankind. The society that is able to create such a system and place it at the service of mankind will be a mature and developed communism established throughout the planet.

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